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IN THIS ISSUE:

Skyway Collisions

IN POSTWAR AIR TRAFFIC WILL BE AVERTED BY NEW INSTRUMENTS. PG. 122

In Full Color:

CUT-AWAY DRAWING OF BRITAIN'S ACE TORPEDO PLANE. PG. 104

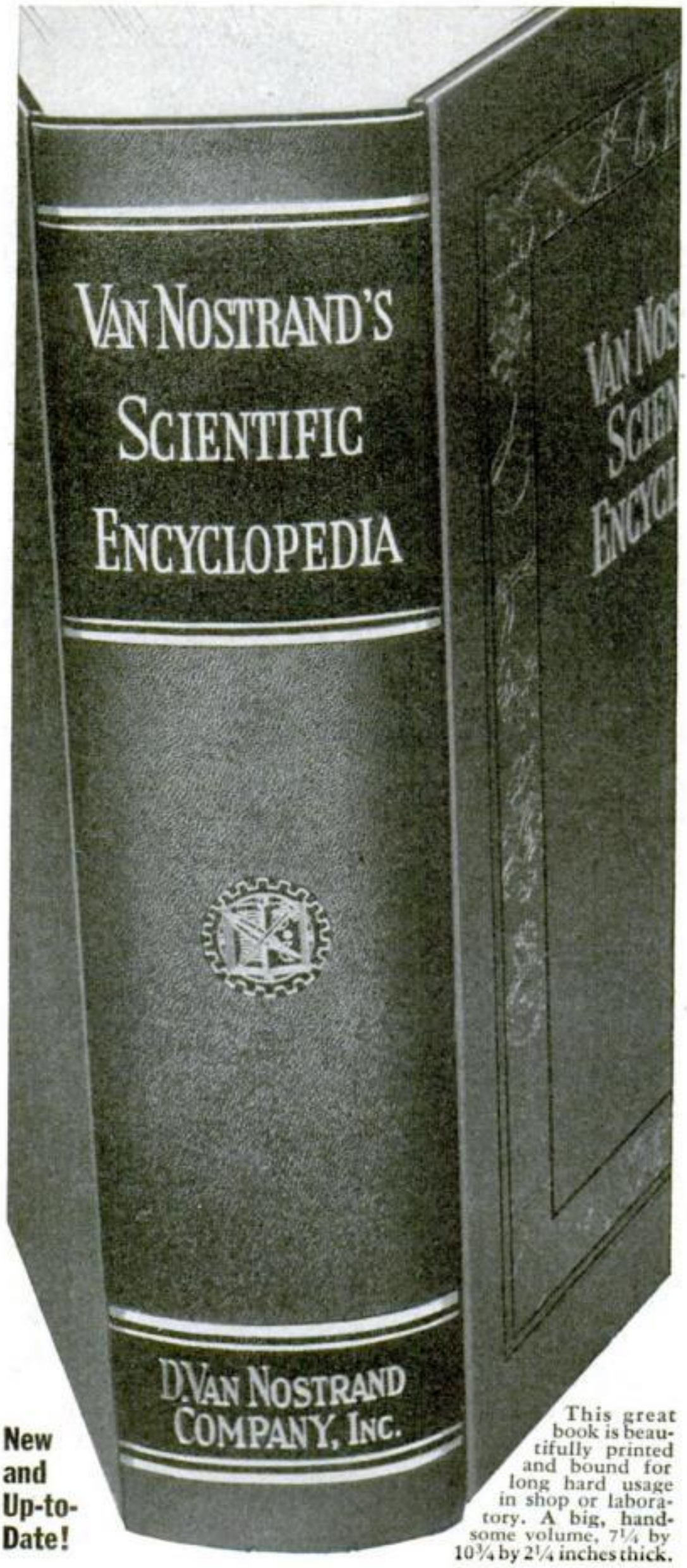
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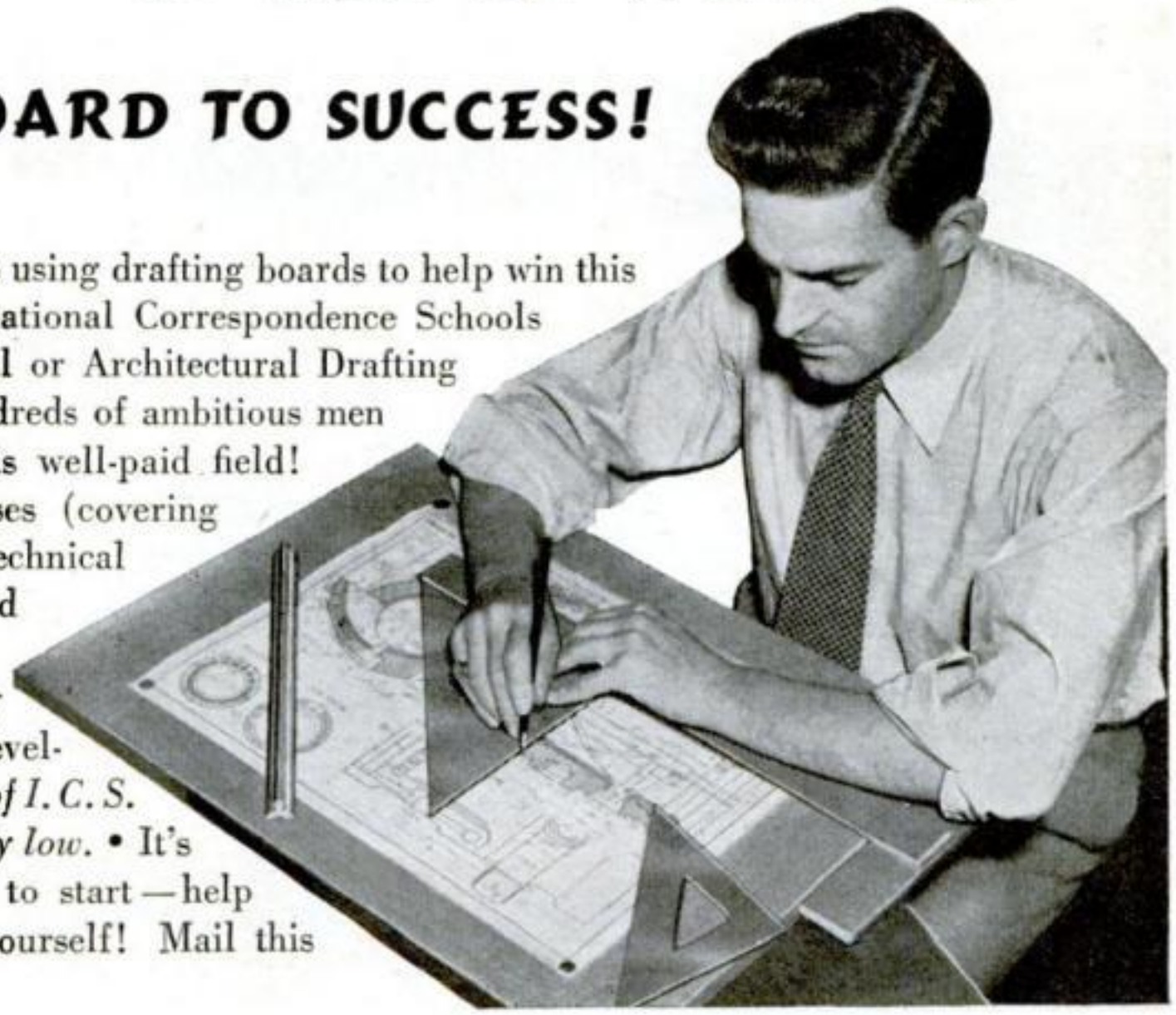
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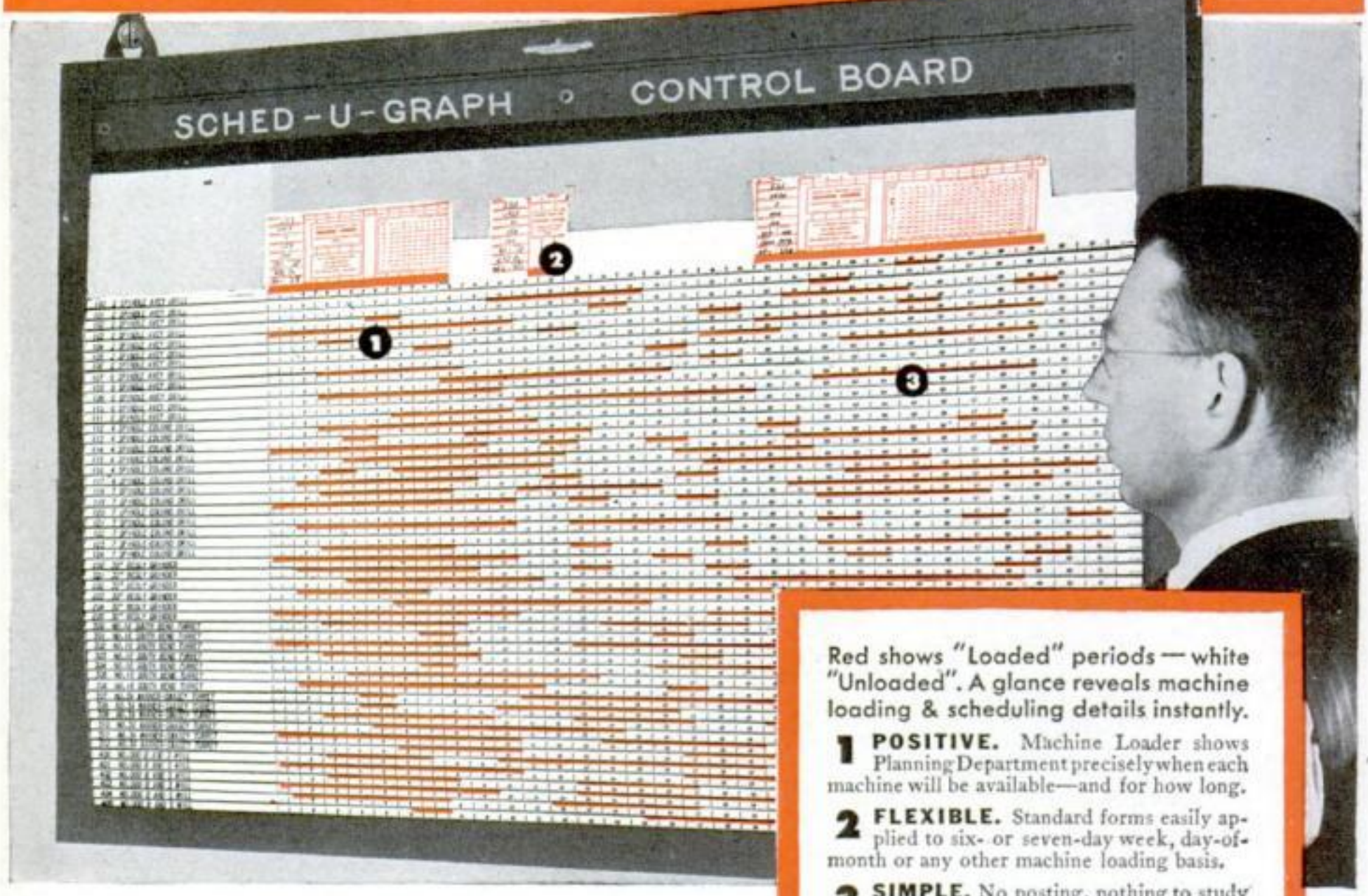
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CONTENTS for MAY, 1944

News

Thunderbolt Ace..... 56A
Weapons Are His Hobby..... 57
How to Read Clouds..... 62
Detour—20,000 Feet Up..... 72
Can We Land Our Planes Safely?..... 75
Jet Plane Poses Problems..... 82
He Gave the Wasp Wagon Its Sting.... 84
Would You Live in a Steel Igloo?..... 92
Why Our Gliders Are Good..... 102
Bristol Beaufort Torpedo Plane..... 104
The Army Finds a Better Way..... 106
Lamps of Tomorrow..... 108
Floating Fuel Tanks for Our Planes.... 114
The Air Age Gets the Green Light..... 122
Ships That Won't Stay Sunk..... 124
Teaching Explosives to Do Tricks..... 128

Automobiles

This Was Germany's Flivver..... 136
Gus Wilson Pulls a Paul Revere..... 138
How to Cure Ring Troubles..... 141

Home and Workshop

Special Jobs for Your Jigsaw..... 152
Silk-Screen Stenciling..... 157
Spring Furnace Repairs..... 164
Milling a T-Shaped Bar..... 170
Houses Are Photogenic..... 176
Rotary Rectifier..... 184
What Is Osmosis?..... 192
Converted Autos Do Tractor Duty..... 196

(Contents continued on page 10)



FIRST ANTITANK WEAPON. Lt. Col. George B. Jarrett (see page 57) displays a .50 caliber, single-shot rifle developed by the Germans in World War I. It weighs about 37 pounds.

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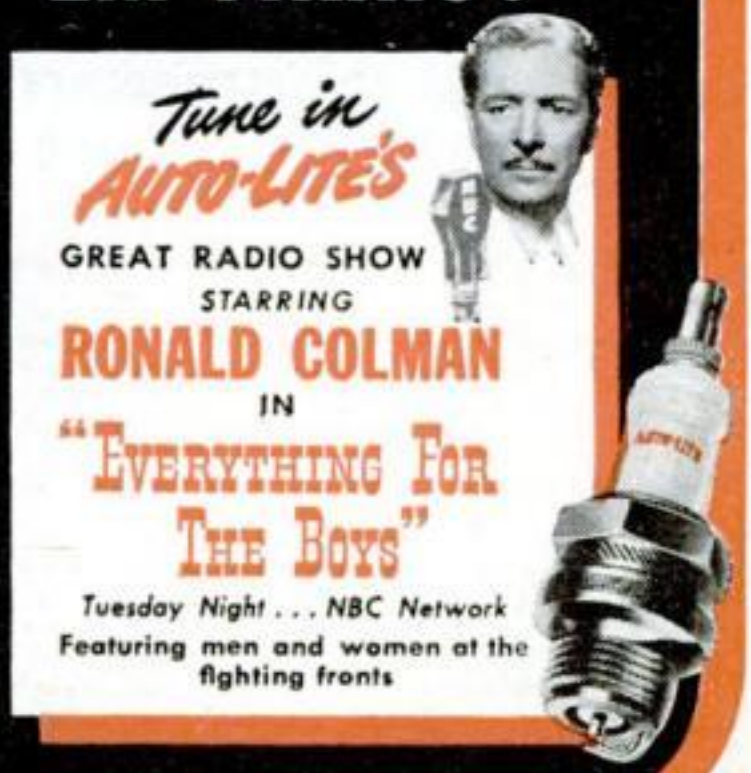
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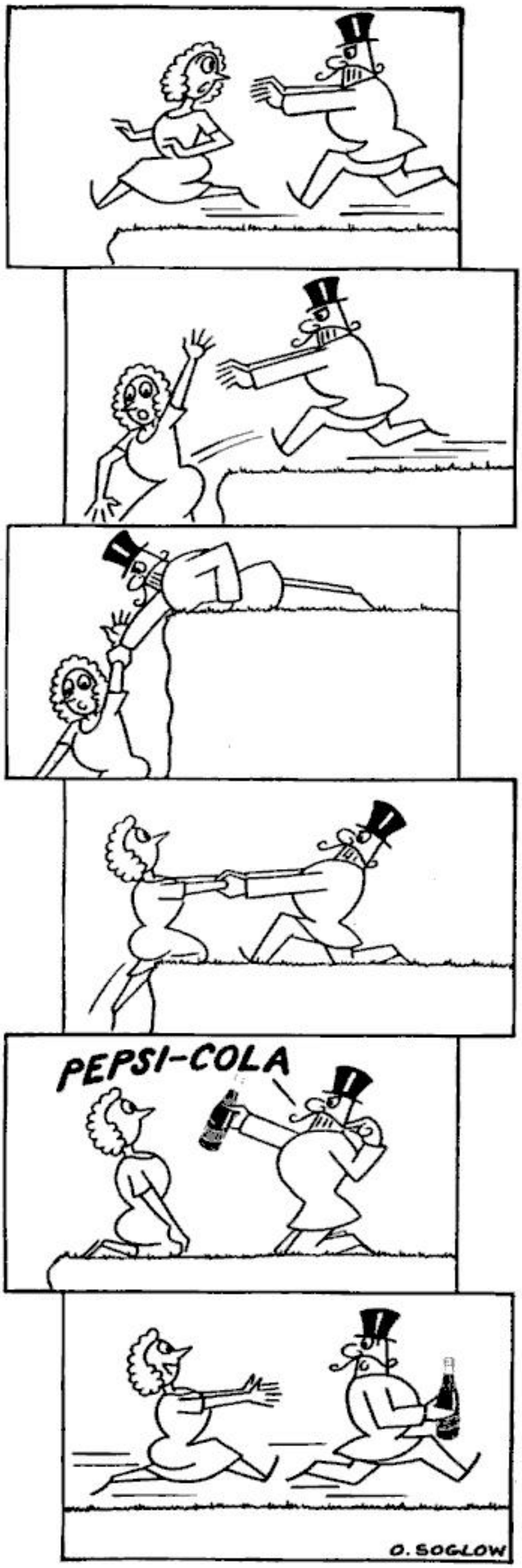
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Contents [CONTINUED]

Craftwork

Signboard with a Silhouette..... 147
Closet-Door Rack for Magazines.... 156
Trees for Your Model Railway..... 161

Electrical

High-Temperature Thermostat..... 182
Better Tone from Table Radios..... 188
Capacitor Is Phantom Antenna..... 189
Lightning Arresters 189

Miscellaneous

Closet Air Conditioner..... 134
Cold-Water Washing Solvent..... 148
Plastic Toilet Seats..... 134
Trailer for a Bicycle..... 149
Pattern Cutting with a Compass.... 149
Conditioning the Lawn Mower..... 150
Table for Out-of-Door Dining..... 169
Home Experiments 190
Question Bee—Clamps and Vises... 195

New Shop Ideas

Double-End Lathe Boring Bar..... 174
Drill Jig for Fine Tolerances..... 175
Abrasive Paper Used for Reaming.. 233

Photography

Cutting Roll Film in the Dark..... 181
Enlarger Mounted on Bumper Jack.. 181
Navy's Photo Science Laboratory... 181
Leaks Repaired in Camera Bellows.. 233

Woodworking

Standard for a World Globe..... 144
Hawkeye—a Reading-Glass Stand... 146
Powder Box Has Jigsawed Flutings. 155

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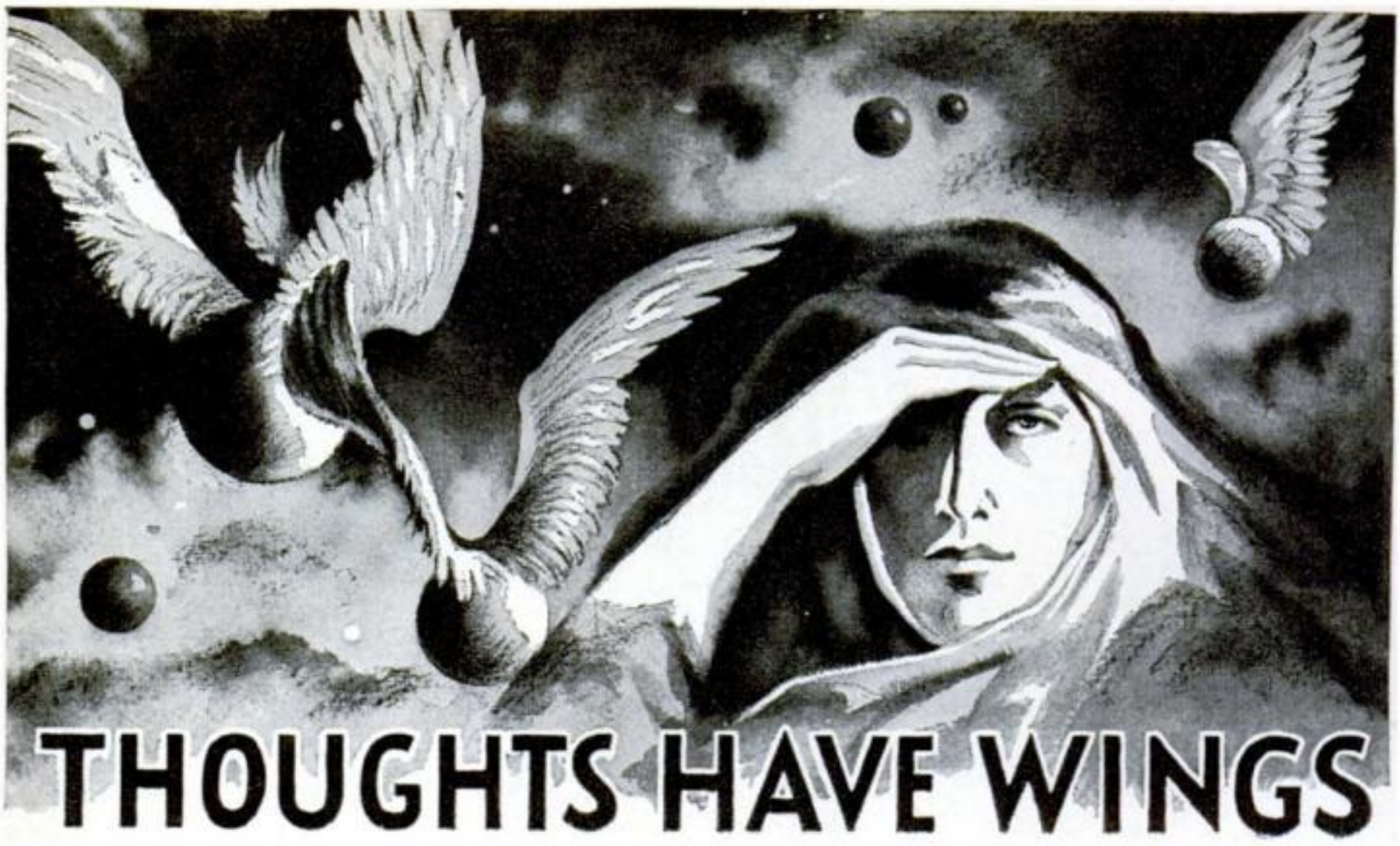
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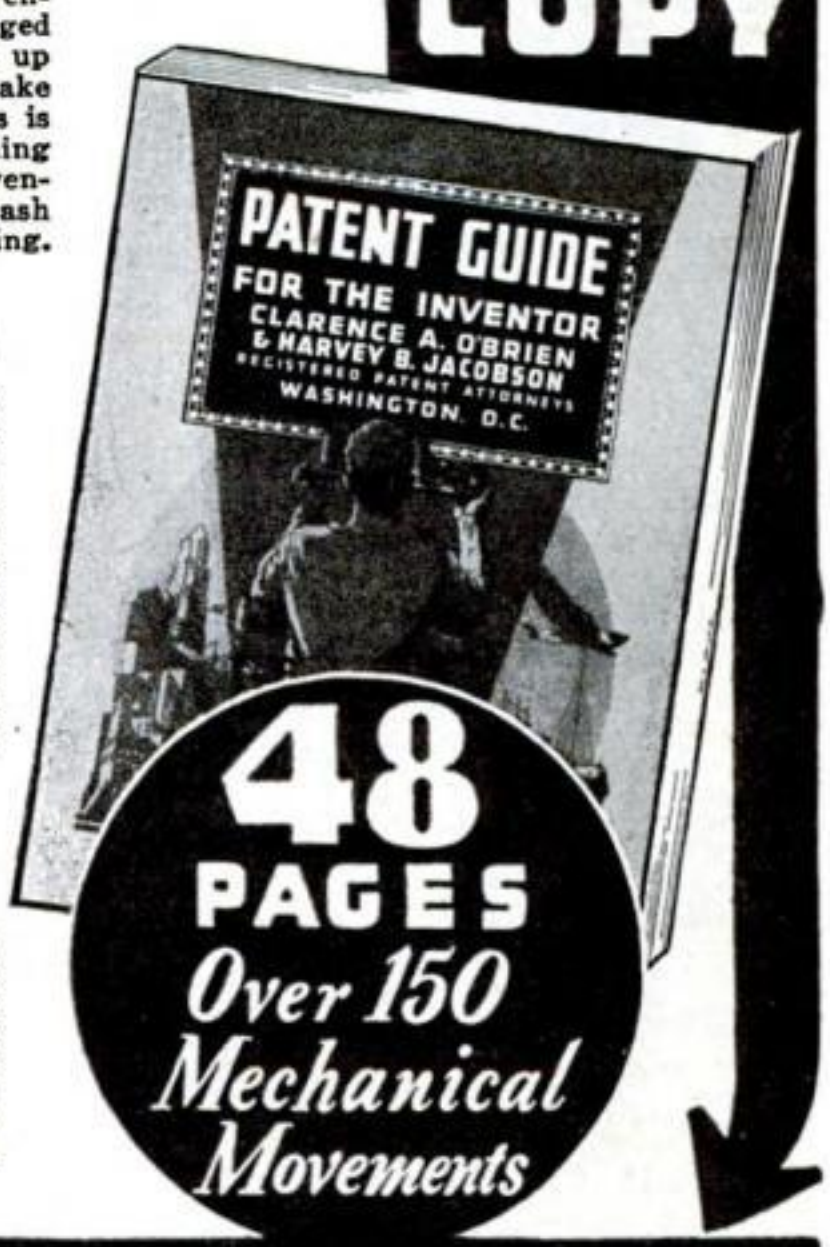
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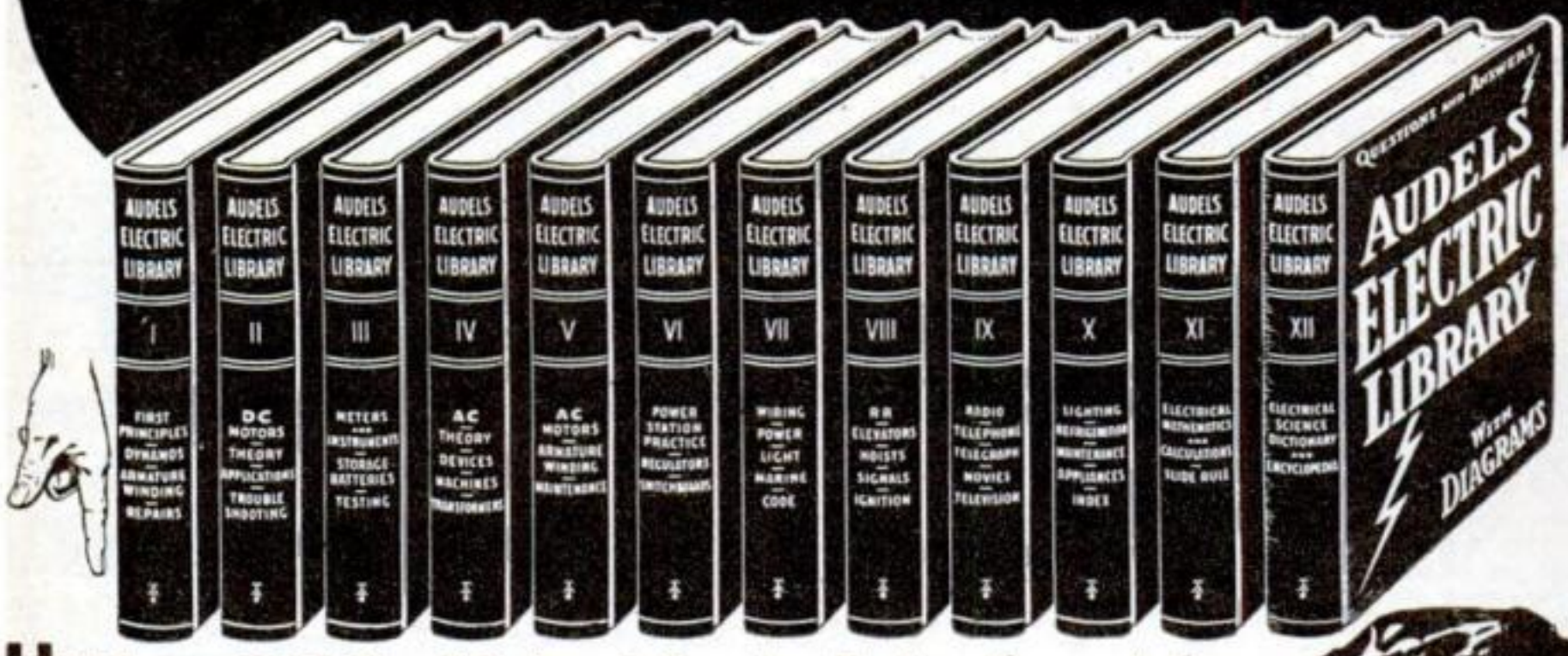
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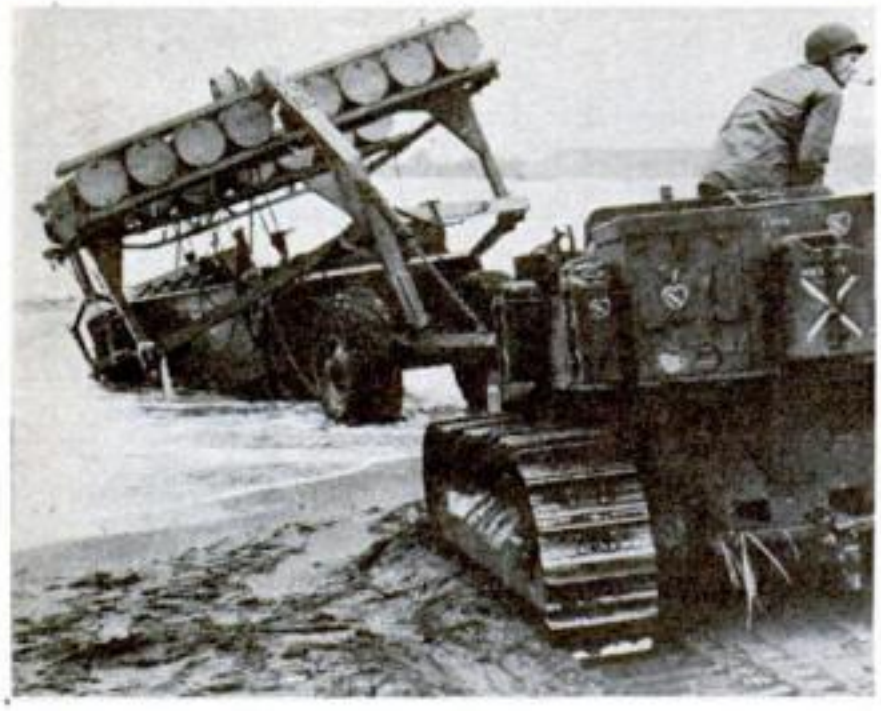
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Readers Say:



Seeing this picture in our November issue, a young soldier in the Pacific wrote home to his mother: "I was on this 'cat' at the time, but like a 'goop,' I jumped off just before the picture was snapped."

We Showed the "Geheney," but Not the "Goop"

MY SON, who is with the Army's amphibious forces in the Pacific, recently sent us a letter enclosing a photograph which he clipped from your November issue. The picture shows a caterpillar tractor (or "cat" as the boys call it) pulling an amphibious machine out of the water at Attu. In your write-up you called it a "geeheebee." My son says "tell them it's called a 'geheney' or a 'gahaney.'" My son was on that very "cat" at the time the photographer snapped the picture, but as he wasn't driving, he hopped off and got behind the photographer—like a "goop," to use his own expression.—Mrs. B. C. M., Portland, Conn.

He Dandled Us on His Knee

I HAVE always liked P.S.M.—and that covers a long time. The first copy of your magazine I ever saw was dated 1872. It was a copy that my father had. Later I had a year's subscription. This I think was sometime in the 80's. Your book is a lot different now—but I still think it is excellent.—E. L. P., Hamilton, Ohio.

The Initial Attack on Anonymity

I HAVE been reading your magazine for some time now and I like it very much, especially your Readers Say. However, there is one thing I must say: at times I have seen some almost ridiculous letters appear in your columns. Is that why you put only the writers' initials, and not their full names, at the end of their letters? Also I would like to know if the compound $V_{12}Al$ is harder than a diamond.—M. E., Dorchester, Mass.

We know of no compound harder than a diamond, nor are we informed as to the composition you mention, which would appear to be an alloy of vanadium and aluminum. As to your other question, by using only a writer's initials, we safeguard his privacy while making available to our readers what it is that he has to say. And we think he should be allowed to say what he likes. By the way, M. E., what did you say your full name was?—Ed.

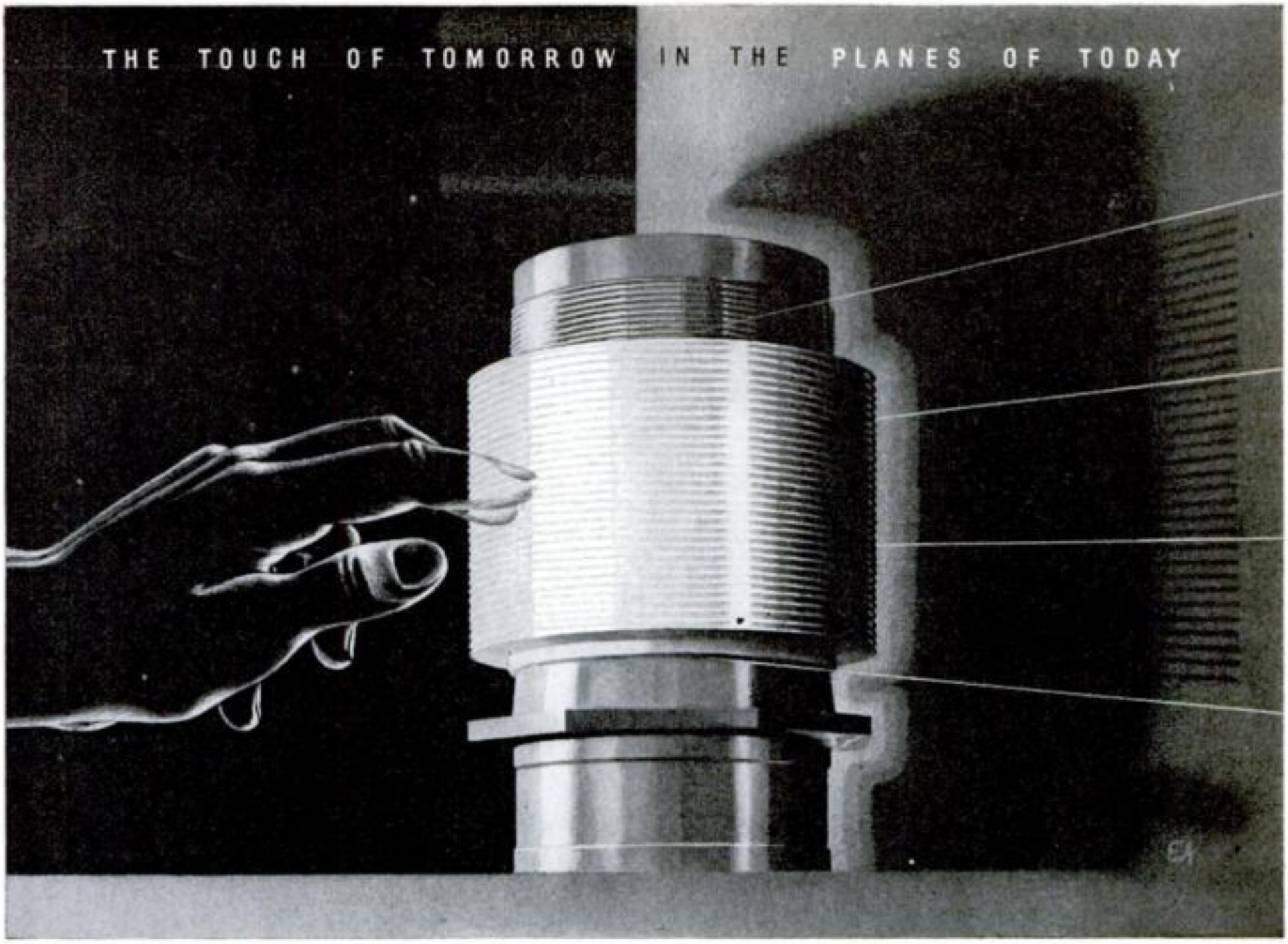
A Salvo of Questions and Answers on Guns

HERE are some questions on ballistics that I, and I'm sure others of your readers, would like to know the answer to. (1) Where in its trajectory does a projectile reach its maximum velocity when fired from a level or nearly level rifle? (2) Are maximum velocity and maximum penetrating power coincidental? (3) What factors, such as air resistance, propelling charge, gravity, momentum, and rifling, condition a bullet's behavior?—T. H. M., New Brunswick, N. J.



(1) A projectile attains maximum velocity just after emerging from the muzzle of a gun, while it is still being accelerated by the powder gases behind it. Except in precision studies, the increase over muzzle velocity is negligible. (2) The velocity of a projectile will affect its penetrating power, but its weight, wall thickness, shape, and material will also enter into the picture. (3) Behavior of a bullet depends on elevation, wind direction, wind velocity, and air resistance; weight, type, and temperature of propelling charge; gravity, weight and shape of bullet, muzzle velocity, and rifling. With large guns, rotation of the earth is another factor in ballistic problems.—Ed.

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Off Comes the Lid of Aircooled Engine Power

Another outstanding engineering development has come out of Fairchild's Ranger laboratories —a new and unique type of aircraft engine cylinder barrel. With it. an aircooled engine can produce appreciably greater horsepower.

What does this mean in terms of air strength for the United Nations? It means that our planes can now have one or a combination of several new advantages: they can carry greater bomb loads; or heavier armor; or more ammunition; they can lift more gasoline and so increase their range; their maneuverability can be stepped up.

The full story of how it works is technical, involved, and shrouded with secrecy. But briefly and in non-technical language, this much can be told:

Those "fins" you see surrounding the cylinder barrel in the picture are made of aluminum, a metal with pronounced ability to draw off engine heat. The core of the cylinder is steel. By all previous methods of manufacture an aluminum alloy "fin" was attached to the core as a separate part. Thus its cooling efficiency was only partly utilized. Now, with Fairchild's "Al-Fin" process, it is possible to *chemically bond* the two metals with the result that engine heat is drawn off much faster than by the conventional aluminum or steel "fin."

The announcement can now be made that all 12-cylinder Ranger engines produced during the past year have incorporated this revolutionary development.

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WINGTIPS

by Abel Grasshopper



AVIATION NEWS AND GOSSIP

Due to the washing out of the War Training Service Program by the Civil Aeronautics Board, some hundreds of primary trainers of the personal plane variety will probably be available for private ownership. Like the good Marines "They've done their duty, and they're ready to do it again." Having established a fine performance record while in Air Corps use they can still give many hours of dependable flying. Until the day when you can get that post-war Aeronca, these jobs will help to "Keep you flying."

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Take a twelve ton hammer...break a trip arm... and bang! goes a vital production schedule. Stir in some hectic phone calls to six different states...then start sweating at the promise of two weeks delivery. Add one resourceful pilot and Abel Grasshopper (an L-3 to you)...results ...just two days and nights...and back to work goes the big press. Another defeat for the Axis.

Such situations become incidents here at the home of "First and Finest."

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"Ding How" say the clever Chinese when they wish to pay top tribute to man or deed..."Ding How" say we to Chinese pilot Captain Yuan Ho who recently visited Aeronca "and departing leaves behind him"...an aura of good English, good fellowship, and good flying.

There are so many trainees in our country from the land of the Chiang Kai-sheks, that Chinese pilots are no longer a novelty, but this descendant of the Mandarins is indeed a man among men. "Ding How" to Captain Yuan Ho, our nominee for Pilot of the Month.

"TRANSLATOR" John B. Kennedy
Famed News Commentator

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Readers Say:

Dark Days Ahead for the Axis

I AM a boy inventor and specialize in booby traps and other devices to terrorize the enemy. I have already sent 10 ideas for war machines to the National Inventors Council and intend to send many more. Among my inventions are a gas cartridge for smoking out enemy troops when they are trapped in caves, closed houses, or armored cars; a handle that can be attached to a bayonet to convert it into a handy death-dealing knife; and a "booby" shell that can be left behind by retreating American soldiers for use by the enemy. When fired, the shell will explode in the gun and splatter the gun crew all over the place. (P. S. When I get into the Army Engineers, it will be a black day for the Axis.)—S. H., New York, N. Y.



Who's Who in the P. S. M. Zoo

WHILE plucking at the coverlet during a long period of sleeplessness last night, I began to wonder how a monkey wrench got its name. Other names for mechanical things were easier to dope out, as, for instance, dovetail, gooseneck, lathe dog, catwalk, bull gear, rattail, and sawhorse. Falling asleep, I dreamed that I had established the Popular Science Zoological park and had entered specimens of all these mechanical animals. I wonder if other readers can nominate eligibles for the P. S. M. Zoo.—E. F. A., New York, N. Y.

P. S. M. Will Be Waiting When He Comes Home

MY HUSBAND is in the Army and has been overseas for nearly 18 months. Each month I read the articles in P.S.M. and then tell him about them in my letters. Perhaps it is only natural that I am mostly interested in the Home and Workshop section of your magazine. I am keeping each issue for my husband.—Mrs. C. E. L., Chambersburg, Pa.

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What good is a $10.00 raise . . . if it then costs you $12.00 more to live?

SURE WE ALL want a raise . . . but raises today are bad medicine. And here's why... Suppose you do get a raise . . . and a lot of others get one, too. What happens? The cost of manufacturing goes up. Naturally your boss has to add this increase in cost to the price he asks the retailer. And the retailer, in turn, raises his price to the consumer . . . that's YOU.

So what good is a raise if your living costs go up even faster?

Of course, it's hard to give up the luxuries of life . . . and even harder to give up some of the necessities. But this is War! And when you think of the sacrifices our fighting men are making . . . many of them giving up their lives for us . . . no sacrifice we can make should be too great.

So . . . start doing these seven things now . . .

1. **Buy only what you need.** Take care of what you have.
2. **Don't try to profit from the war.** Don't ask more than you absolutely *must* for what you have to sell.
3. **Pay no more than ceiling prices.** Buy rationed goods only by exchanging stamps.
4. **Pay taxes willingly.**
5. **Pay off your old debts**—all of them.
6. **If you haven't a savings account,** start one. If you have an account, put money in it—regularly. Put money in life insurance, too.
7. **Buy and hold War Bonds.** Don't stop at 10%. Remember—Hitler stops at nothing!

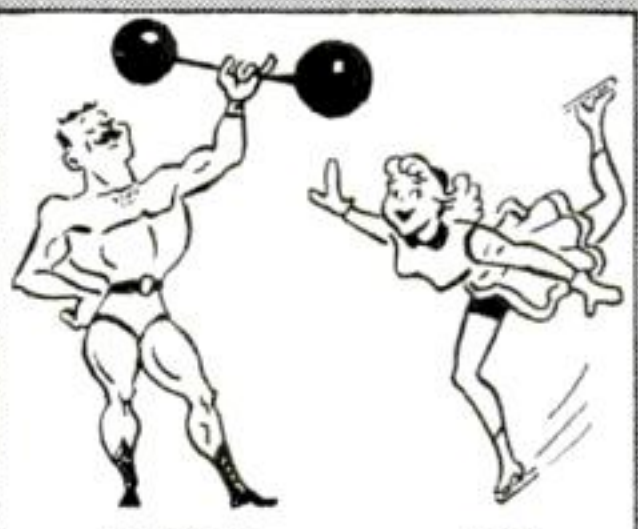
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Readers Say:

Forecasting the Weather with a Pot of Potatoes

WE HAVE approximately the same amount of potatoes for supper every day. The potatoes are cooked in the same aluminum kettle with the same amount of water. The kettle has a cover, around the edge of which steam escapes. Now on humid days less steam escapes than ordinarily—due, undoubtedly, to the high degree of moisture in the air. Yet whenever the potatoes "boil dry," it invariably happens that we have rain that night or the next day. I would like an explanation for this unfailing phenomenon.—W. B., Grand Rapids, Mich.



They Can Give a Whale a Hot-Foot

ON PAGE 98 of the January issue I noticed a drawing of a diver using a cutting torch under water. Is this really possible? I should think the water would quickly douse the flame.—S. P., Wisconsin Rapids, Wis.

It's really possible, S.P. A diver's torch uses the intense heat of hydrogen burning in oxygen, each gas being supplied by an individual hose. A third hose furnishes the air that forms a protective bubble around the flame.—Ed.

Between Complaints He Joined the Army

I THINK that problems or questions that you publish should be answered in the same issue or in the issue immediately following. I also think that where you give a solution to a problem you should explain the method by which a solution is arrived at. Incidentally, the reason that this letter was so long in coming to you is that between the time I began it and the time I finished it I joined the Army. I am now in the Army's Specialized Training Reserve and am stationed at the University of Connecticut.—D. M. R., Storrs, Conn.

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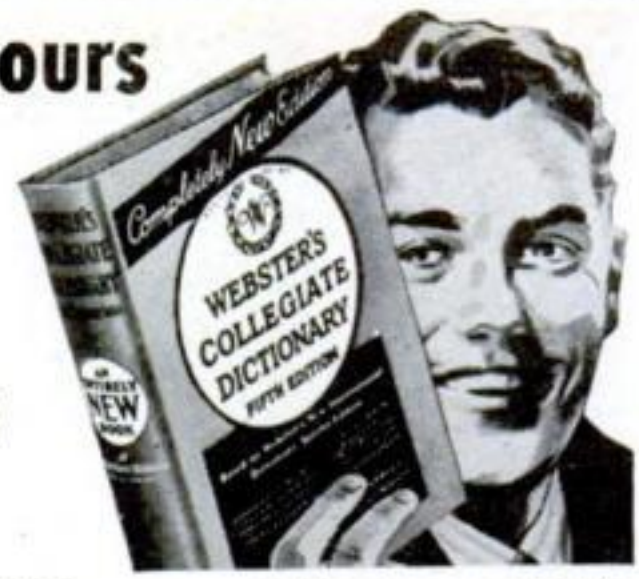
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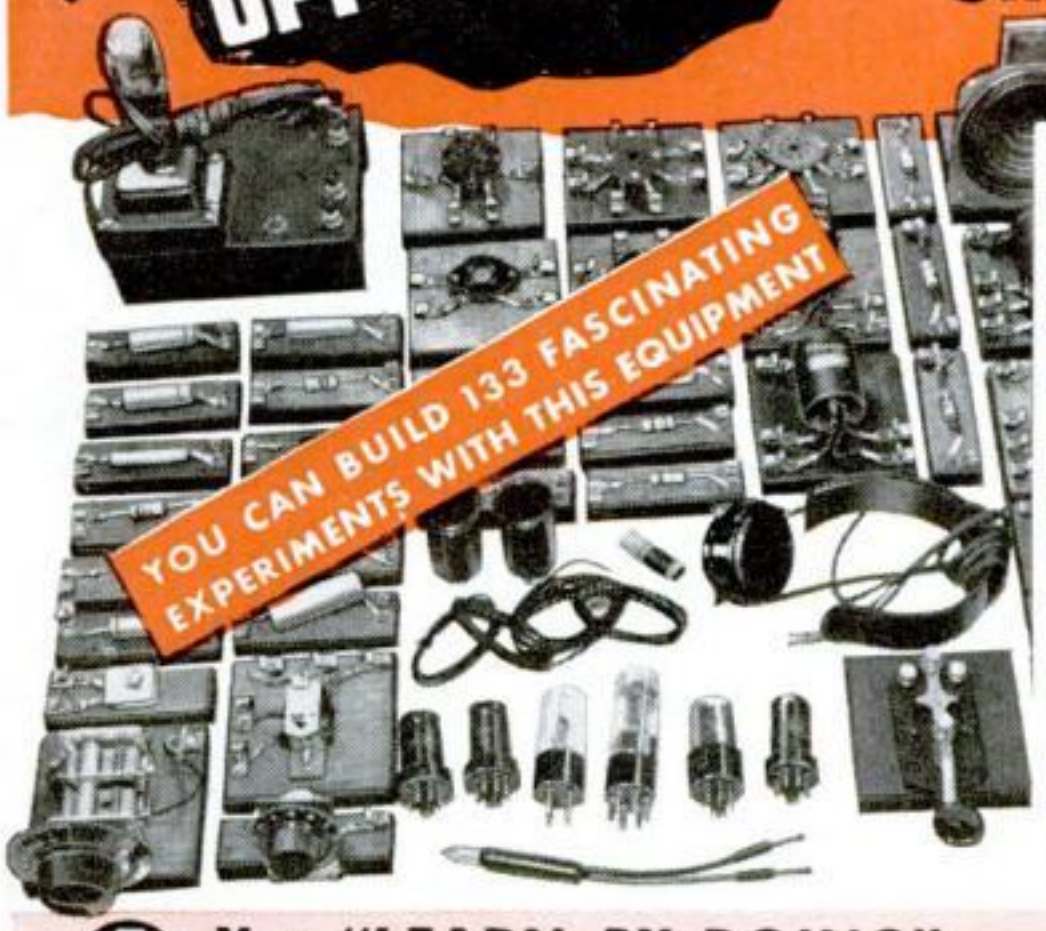
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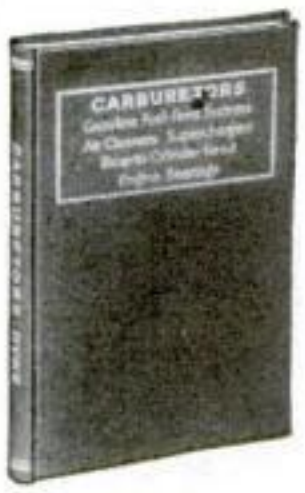
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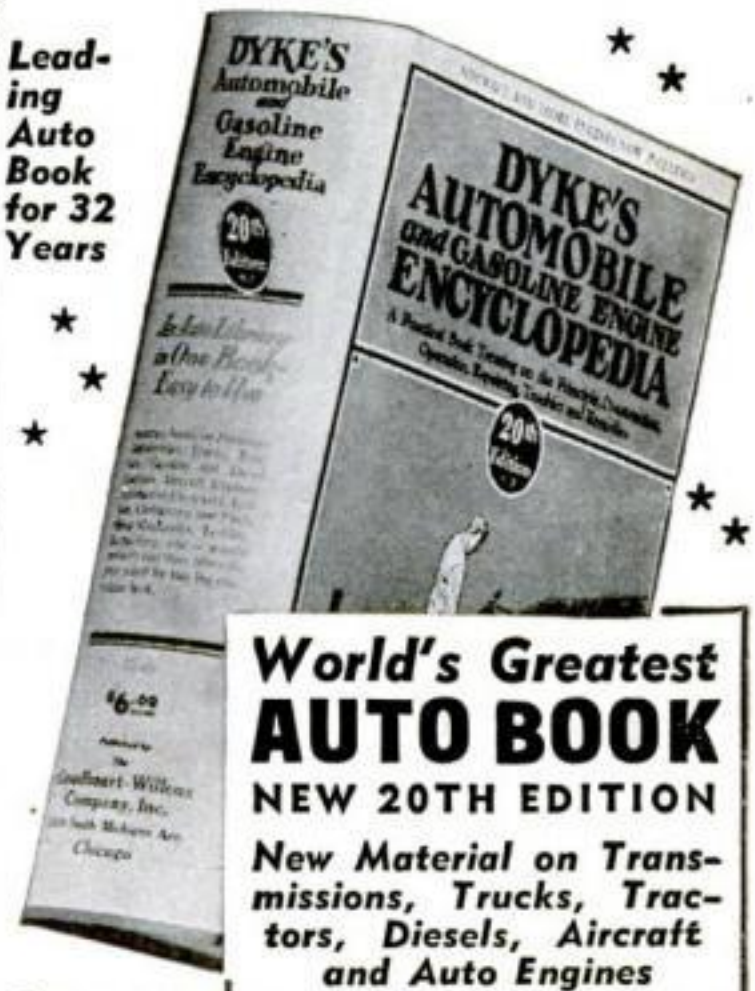
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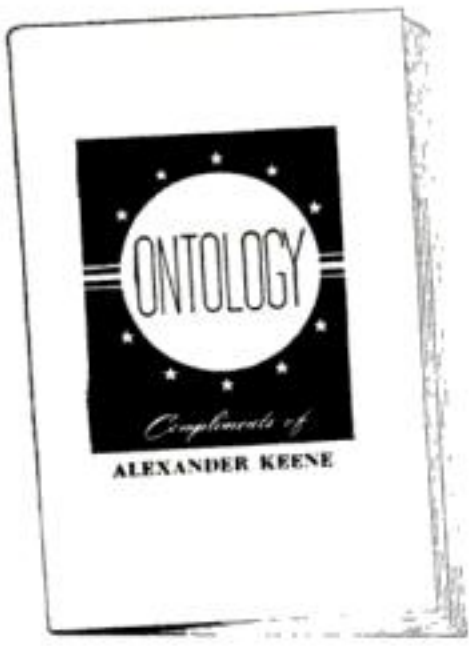
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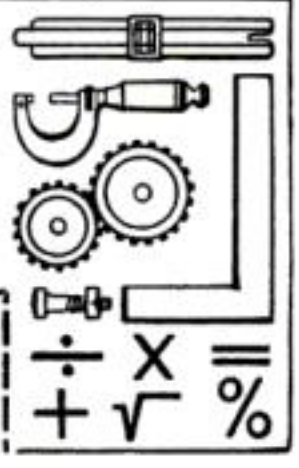
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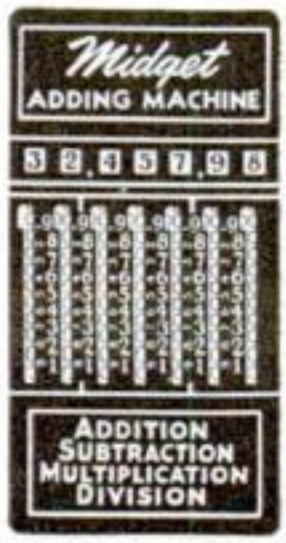
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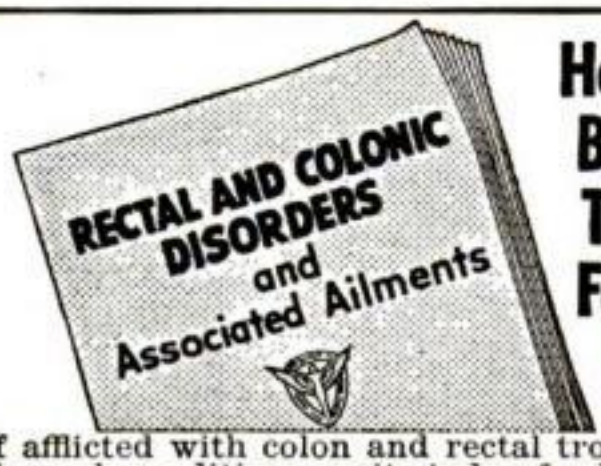
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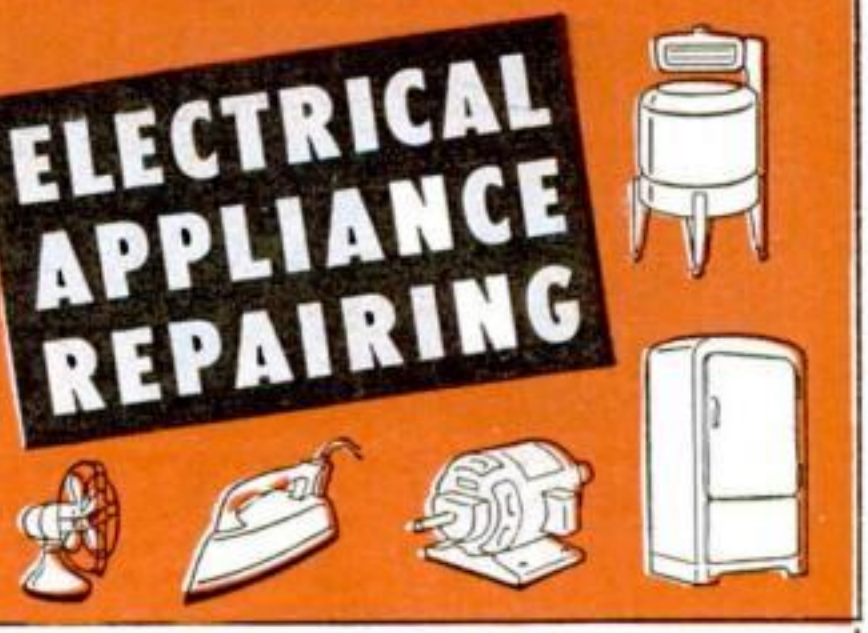
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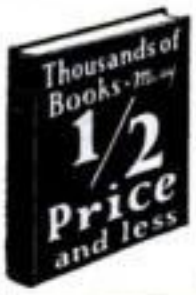
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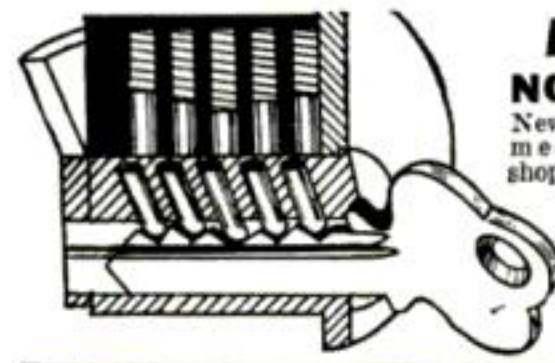
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FARM AIRDROME. From a wet, muddy airfield in England, with asphalt roads and runways laid down in the midst of farm land, the P-47's go forth to battle as escorts for bombers. One squadron has its headquarters in a 300-year-old farmhouse. At the right is Capt. Walker M. Mahurin, one of the leading American aces. When this was written, his score was 20 Nazis

One of the secrets of our devastating raids on Germany is the bomber-escort work of the Republic P-47. Here's the story of a leader in that epic fight.

What It Takes to Be a *Thunderbolt Ace*

By HICKMAN POWELL
Photos by HAROLD KULICK

Popular Science War-Front Reporting Team

THE Thunderbolts had just returned from Osnabruck to their airdrome near the east coast of England, base of the hottest American fighter group in the ETO.

Rumpled and tense, flushed with combat, the boys jostled into their squadron room. Mahurin had led the squadron that day, escorting the heavy bombers. It was he who made the report, as his comrades loosened their flying clothes, grabbed for sandwiches and coffee, and relaxed in the rows of chairs in front of the big map.

Lanky almost to the point of stringiness, Mahurin gestured easily with his long arms to chart the flight across Germany. He was calm and matter-of-fact, with only a gleam in his eye to hint at anything unusual. Course, time over the enemy coast, weather —the intelligence officer, Robbie, already knew much of what Mahurin had to tell, for he had been listening on the RT as the P-47 fighters talked through their mission. The little friends had made rendezvous with the big friends right over the airdrome which was the target.

"And was it there you saw the bandits?"

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BRIEFING prepares the pilots for a mission over Germany. Here Col. Robert S. Landry, commanding the group, gives his flyers the dope on the job in hand—guarding a box of bombers on part of the long trip into Naziland and back



HANDY NOTES are jotted down by Mahurin with a fountain pen on his palm. Most pilots use the backs of their hands and make fairly copious notes during the briefing process. "Bud" jots down just three critical details: time of starting engines, course out to the rendezvous, and course home



PARACHUTES are donned in a room dominated by black cats (see page 56H). If a pilot has a slight cold, he gives himself a dose of nose drops. In peacetime, a sniffle would ground a flyer, but things are different in wartime England



OUT TO THEIR PLANES go the pilots as the time for take-off nears, riding to their dispersed aircraft by jeep. Sometimes (but not this time) when the P-47's are all ready to go, a rocket announces that the mission is called off

asked Robbie, continuing the interrogation.

"Uh-huh," said Mahurin. "So we bounced and—we got two. They were FW-190's—I think."

Whisky almost shouted, sputtering through a mouthful of Spam, as he lunged forward. "Walker, those were two ME-109's that you shot down!"

A 109 is a much tougher customer than a 190, it seems. Above 20,000 feet, an FW-190 is easier to catch and, when hit properly, it flies to pieces like a bucket of bolts. Whisky was Mahurin's wing man that day and was still protecting him. One thing Lt. Adam J. Wisniewski would not stand; and that was for anyone, even Mahurin himself, to detract one iota from the glory of Capt. Walker M. Mahurin, one of America's leading aces in the European theater.

This was the day Mahurin got his thirteenth and fourteenth Germans, in a span of just over four months. It was the first time he had flown in more than three weeks. Meanwhile he had been away at the flak farm, a wonderful rest home where pilots loaf around in slacks and sweaters, play

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SYNCHRONIZING WATCHES. After listening intently to their instructions, the flyers check their timepieces. Co-ordination is vital in bomber-escort work; the "little friends" must keep their rendezvous with the "big friends," whether it is over the target or on one leg of the trip

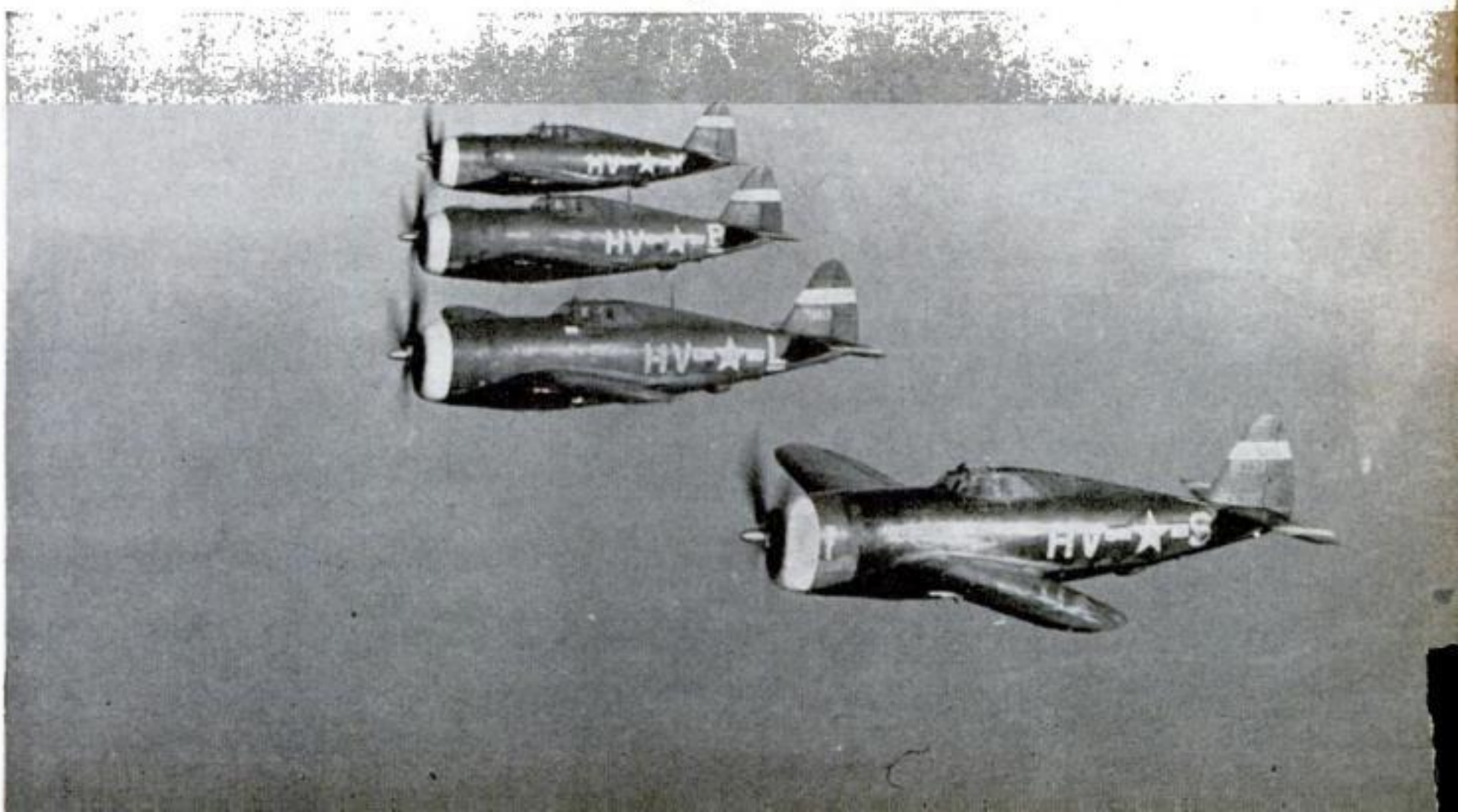


RAIDING THE PANTRY comes before raiding the Reich. When briefing is finished, the boys stage a blitz on the squadron's food lockers. Then they kill time until the starting hour in the pilots' room, located in a large Nissen hut



TAKE-OFF. Taxiing out to the runway, the fighters line up and take off two at a time. The two-plane element—leader and wing man—is the basic unit of fighter tactics. Whatever happens, the element must stick together, wing man covering his leader at all times. If leader is good, wing man gets few chances to shoot

IN THE AIR. Two two-plane elements make a flight; four flights (16 planes), a squadron. On an escort mission, the fighters fly high above the box of bombers. Because they are faster than the big B-17's or B-24's, they must fly a zigzag course. This burns up gas fast, necessitating several relays of fighters per mission





LISTENING IN on the radiotelephone at headquarters, comrades hear the pilots of the mission talking to each other in combat. One of the intelligence officer's clerks takes down flight record

badminton, ride horseback, talk to the Red Cross girls, and try to forget about the war. He had gone to the flak farm after a week during which, in two raids on Bremen, he knocked down four Messerschmitts. And now he had killed two more. Mahurin nearly always takes the enemy in twos and threes.

This day at Osnabruck, just as the first box of bombers was turning back, Mahurin spotted two Jerries making a large left turn at 24,000 feet. He went into a dive, with Whisky following 100 yards behind. As they swooped, the bandits went into a small cloud, but one came out and Mahurin was after him, opening fire with 45 degrees deflection at 500 yards.

As Mahurin closed in, the enemy conveniently straightened out and headed for the bombers. Slightly below him, his pursuer could see his belly tank and two rocket containers. Firing steadily, Mahurin gave his P-47 everything she had. He started getting hits at 300 yards. Closing rapidly, at 100 yards he hit the belly tank. As the enemy ship blew up, Mahurin flew at seven miles a minute through the debris and flames.

Mahurin turned left and was surprised to find the other bandit near him, heading for the bombers. He started in pursuit, but the bandit spotted him, fled upward directly into the sun. Mahurin followed, straight into the blinding glare, which blanked out the reticule of light in his deflection sight. He started firing blindly into the sun, then saw smoke and fired at the smoke. Suddenly the enemy came into view, all in flames, turning over to dive to his destruction.

It's small wonder that the boy was not quite certain about all details. As a matter of fact, he says that when he gets in an engagement he doesn't think. For months he trained, judging angles, memorizing formulas for speed, range, and degrees of deflection, just as though they were multiplication tables or five-finger piano exercises. In action these things become second nature.

Probably everybody by this time has heard about Walker Mahurin and his record of kills. This article is an attempt to get at some of the details of how he fights with a P-47, a Republic Thunderbolt, and some of the reasons why he is so good. It is the fruit of several long talks with the flyer himself and with the men who fly with him. Though he has been showered with decorations and been to tea with the Royal Family, only time will tell what rank he will hold among the war's heroes; but already he was a hero to his own gang.

COMBAT MOVIES also preserve a record of action. A motion-picture camera mounted in the wing of each Thunderbolt takes pictures at 64 frames per second whenever the guns are fired. At left, below, film is being removed from a returned fighter. Projected on a screen (right) at normal speed, they provide a slow-motion, blow-by-blow picture of the action. At Fighter Command, they are analyzed by precise mathematical methods which show when a hit was scored or why the fighter pilot missed his quarry





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Joe Egan called him Skinny, and wished he could get Skinny to relax a few minutes between kills. George Hall called him Bud, and wished he could get Bud to go on a party. Whisky called him Walker, and wished he might always fly on Walker's wing.

The Thunderbolts always work in elements of two—two elements to a flight, four flights to a squadron. The fighters fly above the bombers, ready to bounce if they sight bandits attacking. But if one flight bounces, another flight stays aloft to cover it, ready to dive to the rescue if more enemies appear. Or if one element bounces, the second element of its flight stays aloft. Always there is this teamwork for protection. In a bounce the element leader has his wing man close behind, to cover him.

The wing man has a thankless job. He takes a major part of the risk, gets little of the credit. If his leader is as good a gunner as Mahurin, the wing man hardly even gets a chance to shoot. But Whisky would rather fly on Walker's wing, almost, than lead a flight himself.

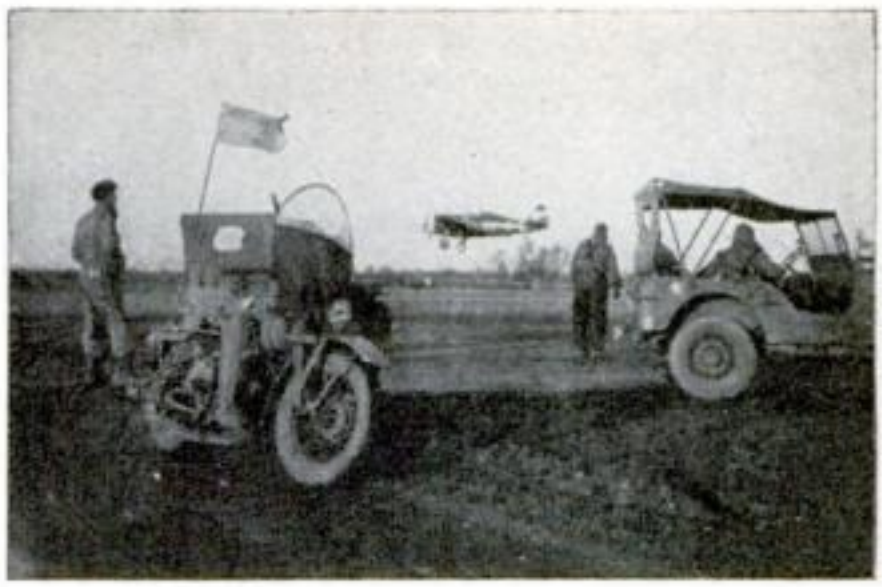
II

Early last August Bud Mahurin was taking a dim view of himself. He was browned off, discouraged, almost resigned to being a failure.

One of our first Thunderbolt pilots, he came to England last spring with the first P-47 group, three squadrons which later were to gain fame under command of Col. Hubert Zemke. Right from the start he was a flight leader, with opportunity to show his stuff. But nothing seemed to go well.

On his very first bounce, Bud felt he had made a fool of himself. Spying five FW-190's far below, he led his whole flight down. He didn't know enough about high-altitude flying yet; and rushing ahead of his three followers, he got going too fast. Just as he was about to attack, he hit compressibility. It banged him like a club.

(In the P-47 and P-38, aircraft have attained the ability to equal or surpass the speed of sound. This is especially true in the chill atmosphere of high altitude, for the speed of sound varies with temperature: at 59 degrees F., it is 760 miles per hour; at 50 degrees below zero, it is only 683 m.p.h. At the speed of sound, the behavior of air against an aircraft wing suddenly changes. Instead of flowing over the airfoil, it piles up in front of it. The aircraft is buffeted, it stalls, its tail surfaces are blanked out in unstable air. Even before sonic speed is reached, local compressibility conditions develop over rivet heads and between struts, jolting the plane.)



HOMECOMING. Their job done, the Thunderbolts return. Jeeps, ambulance, and fire wagon are out on the field to welcome them and take care of any emergencies that may arise as damaged planes land



BACK TO EARTH, the pilot alights and turns the plane over to a ground-crew man. This time the belly tank has been brought back; tanks are dropped only when necessary for speed in combat

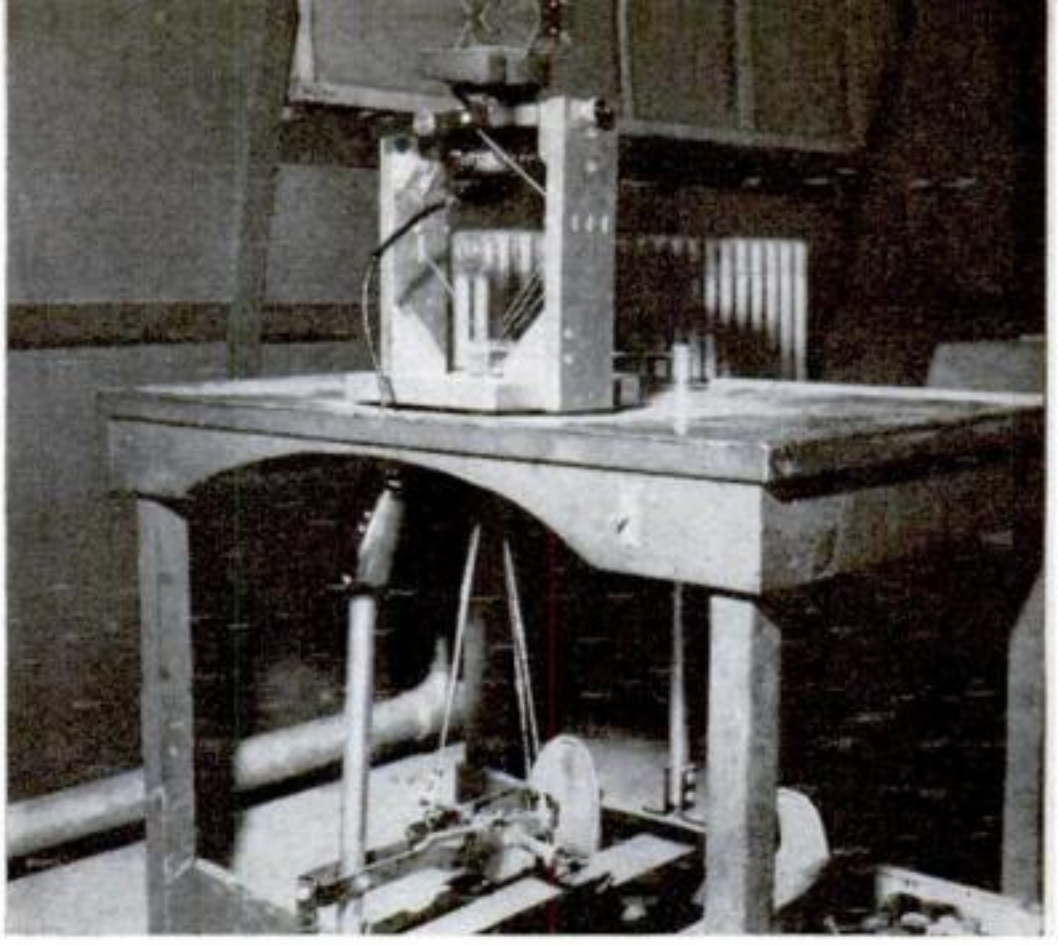


INTERROGATION by the intelligence officer is the first order of business. Whisky (at left) describes a kill made by Mahurin (holding cup)

When Mahurin tried to roll out of his dive, he stalled and wound up 500 feet below, staggering right across the noses of the five FW's he had set out to slaughter. They were firing on him from 150 yards. One hit his right wing, nearly tore it off, threw him

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GUNNERY PRACTICE helps fill the time between missions and sharpen shooting eyes. At left, above, Mahurin (seated) is using the Beatie deflection trainer. Aiming at a scale-model FW-190, he calculates the proper lead. Whisky then inserts a calculating rod in the nose of the model; a target on the rod shows where the sight should have been centered. The trainer (right) is a standard deflection sight attached to plane controls



BREAKING IN new men is another between-times job. Here Mahurin, like a football coach, is using a blackboard to show some newcomers the group's battle tactics

from a vertical bank on the left to a vertical bank on the right.

Somehow he got away and hightailed for home, feeling very sheepish. Still, he had learned a lesson. A 7,000-foot dive was not so good. A good pass was about 2,000 feet, from up-sun. Then you had control of what you were doing.

Bud's next seven sorties were not encouraging. Then, early in August, he got tangled up one day with the tail of a Liberator while flying over England, damaging his aircraft so badly that he had to take to his parachute.

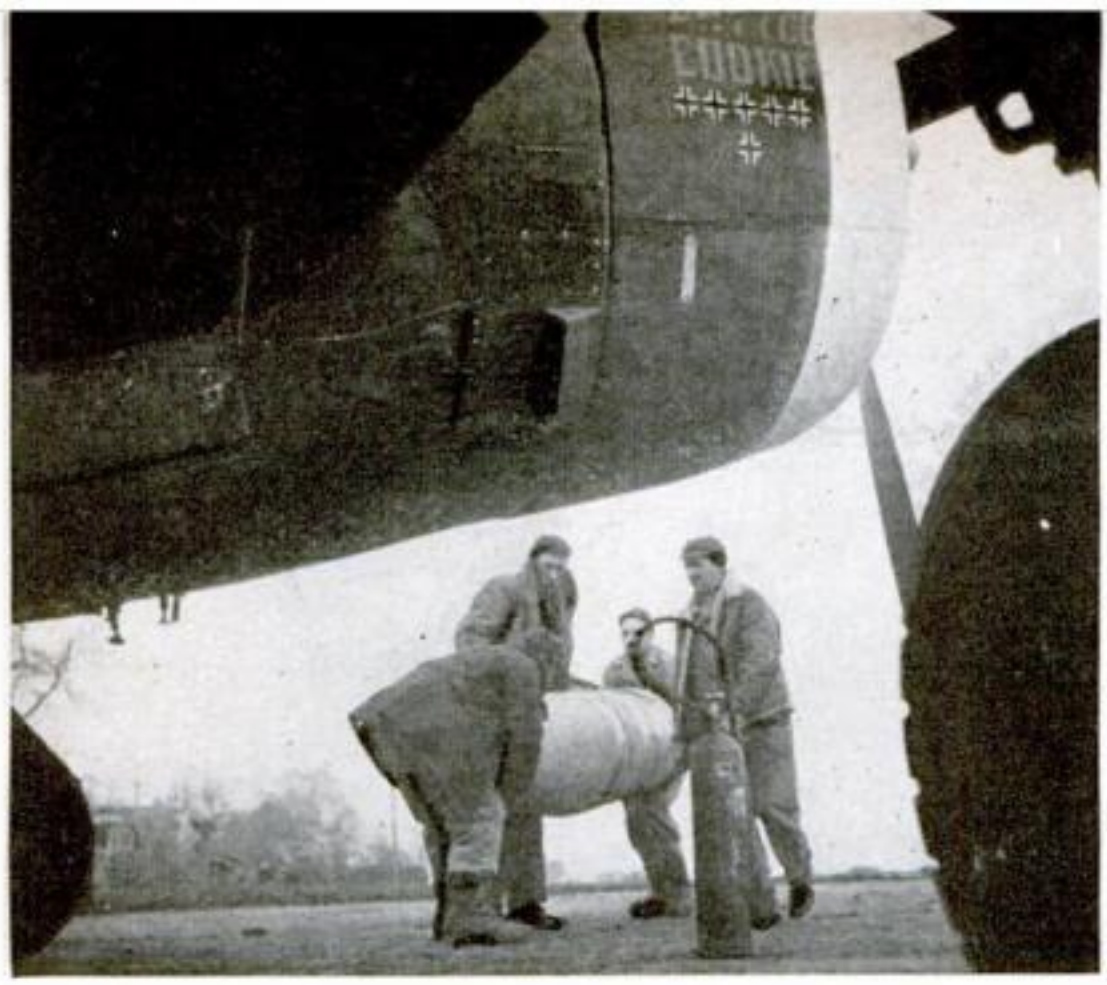
What made it worse was that his group at this moment was starting to get hot. These three squadrons, which wound up the year with a total of more than 160 verified kills, did not destroy many Germans at first. They made sweeps and patrols over the Continent. Sometimes they escorted

GUNS get a thorough going-over between missions. At left, below, one of the eight .50-calibers is being loaded through a hatch in the wing top. At regular intervals, the guns must be bore-sighted as a check on accuracy. A crane lifts the plane to flying position (right) so that targets can be lined up by eye through the barrels

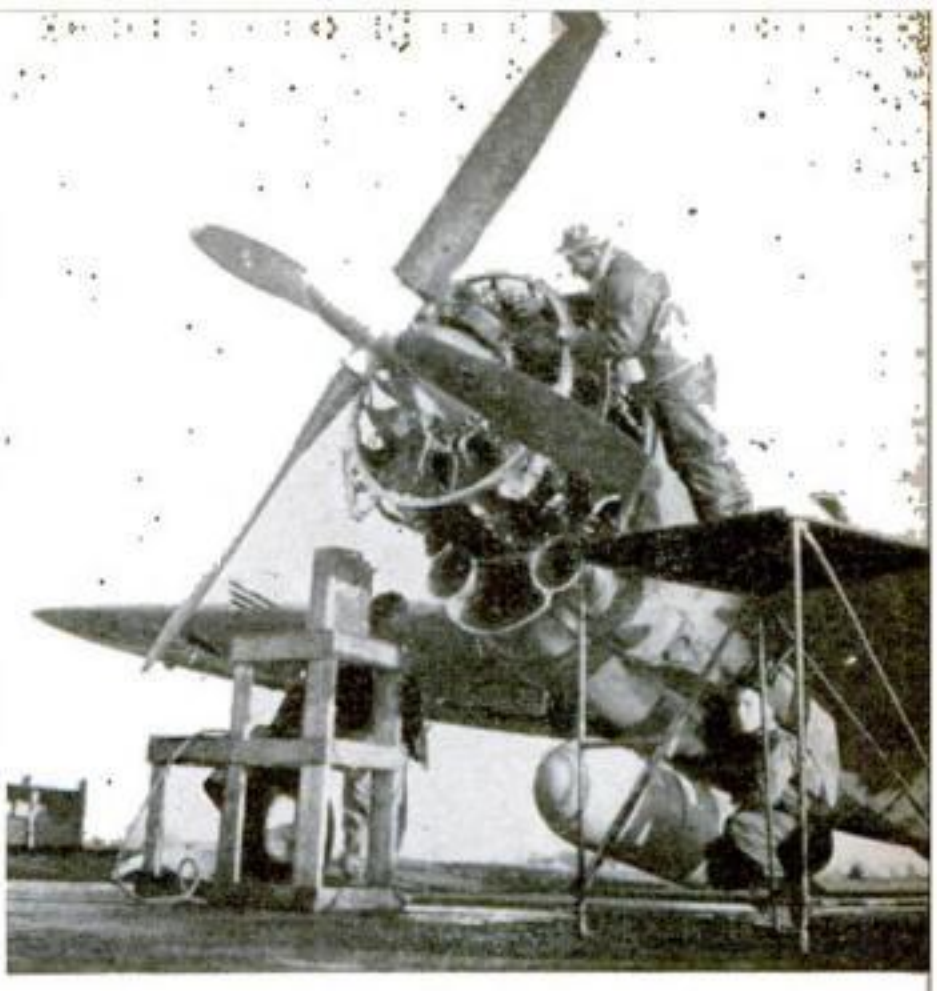




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BELLY TANKS are reloaded and charged with pressure to make them work at high altitude. Notice the six black crosses on the nose of this plane; each stands for an enemy shot down. Some pilots prefer swastikas



ENGINES come in for attention, too. Here cowling has been removed from the 2,000-horsepower Pratt & Whitney Double Wasp by ground crewmen. The scoops seen beneath the engine capture air to cool off the oil

bombers. They got familiar with their new aircraft's behavior in combat, got the feel of the air five miles above Europe. Then suddenly they gained confidence, and with confidence came aggressiveness.

New equipment gave another boost. The belly tank, pressurized to work at high altitude, adding as much as 200 gallons to fuel capacity, came into use at the end of July. Before Jerry had discovered the increased range of the Thunderbolt, he had been surprised and slaughtered three times.

It was on one of these raids, August 17, that Mahurin clicked. This was the first raid on Schweinfurt, the same day as the more famous Regensburg show. That day Mahurin had his first victory—a double kill. This was the first of several times he saved the life of his wing man, George Hall. It was also the first occasion on which he demon-



SHINING UP. Staff Sgt. John E. Barnes, of Fostoria, Ohio, heading Bud Mahurin's ground crew, puts a little elbow grease on the surface of an elevator

GROUND CREW goes over every working part. These men don't get mentioned in dispatches, but their careful, painstaking work plays a big part in air combat



VACUUM-CLEANING removes mud tracked into the cockpit. In a plane that often flies upside down, mud on the floor may fall right in the pilot's face



strated a quality which his comrades believe accounts for much of his success: an ability to see more than anyone else.

In the vast, three-dimensional spaces of the upper atmosphere, filled with hundreds of aircraft, they say Mahurin has an uncanny ability to size things up quickly, see and understand what is going on, and decide instantly what to do. This is especially important in a Thunderbolt. This heavy, high-powered teardrop is a hit-and-run ship. The pilot has to call his shots, engage the enemy suddenly and surely, then break off and get back to altitude.

At this point we had better orient ourselves in the upper atmosphere. A box of Fortresses, flying to bomb Germany, comprises one wing—that is, three groups of 18 bombers, three squadrons to each group. These bombers are so arranged in three-dimensional formation that their guns protect each other.

High above the box fly the escorting fighters. Since they are faster than the bombers, they almost necessarily fly an S course, or frequently orbit, in order not to outrun the box. Of course this uses up fuel rapidly, and to keep the bombers continually under escort it is necessary to have fighter groups going out in relays to relieve one another along the course.

The bombers sometimes go beyond fighter range, and that is where the Nazi planes wait for them. That's where they were waiting when the belly tanks surprised them. One German trick when they find a box short of escort is to send swarms of fighters on it at two o'clock and ten o'clock, coming to the bombers head on, then swinging around in a big orbit to come in again. The bombers can knock down fighters in an attack like this, but the fighters get a lot of bombers too.

On this August 17, over Eupen on the way to Schweinfurt, as the fighters S-ed along far above the bombers, with all the usual hindrances to visibility, there was not a German fighter in sight. No doubt the Thunderbolts weren't visible either, since theirs was a surprise visit.

Suddenly, down among the rear bombers in the box, Mahurin saw bursts—small shell bursts. Abruptly he started into a bounce, and he was less than halfway down when he saw that he was right.

Over their own territory the Germans use 20-mm. shells which are self-destructive, so that they do not explode on hitting the ground. The shell bursts Bud had seen were those from FW-190's. As he dived, the FW's emerged from the rear of the bomber formation and swung right and left in wide orbits, to return to the frontal assault.

Bud bounced hard on the tail of an FW turning into the left orbit, and its pilot never knew what hit him. (Fighters need eyes in the backs of their heads. Those who are shot down hardly ever do know what happened.)

Bud pulled out of his pass in a hard, short turn, as he always does, and came back in. There was George Hall, his wing man, hot in pursuit of another FW, scoring hits. And on George's tail, closing for the kill, was a third German.

Bud roared in on No. 3, blasted him into flames. George's quarry (later listed as a probable) broke off into a smoking dive, and George returned to Walker's wing. All of this took less time than reading the paragraphs that tell it. Meanwhile, other Thunderbolts, bouncing into the right orbit, had slaughtered three more.

Homeward bound that day, Bud Mahurin felt very different. He had confidence now. Training is complex. Deflection shooting is all mixed up with theory and formulas about range, speed, radii of the circle in your sight. But once a man meets and masters the real thing, it becomes simple.

Why, shooting the eight guns of a Thunderbolt was just like squirting the garden hose.

III

When Bud thinks of shooting as though it were like squirting the hose back home in Fort Wayne, Ind., his analogy is perhaps more apt than that of Joe Foss, who explained his score of Zeros in the South Pacific by saying it was just like shooting ducks. The firepower of a fighter plane is a stream of bullets, a squirt spreading into a small spraylike pattern.

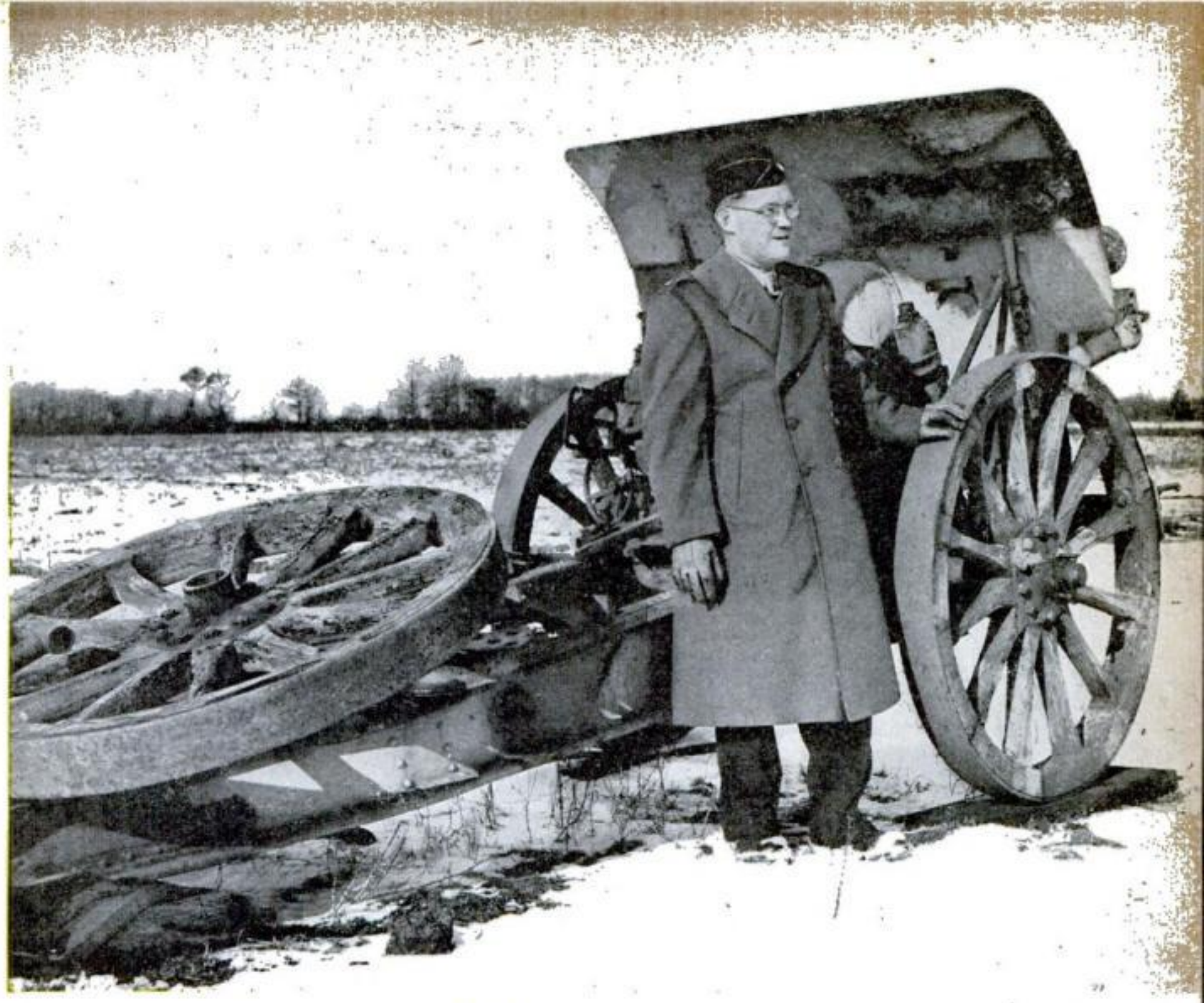
Imagine a small boy running across the grass in a bathing suit. With the hose nozzle turned to its hardest, straightest stream, you are trying to squirt him. This is deflection shooting. Your nozzle is the pursuing aircraft.

(Continued on page 212)

GOOD LUCK? Here's the story of those black cats in the parachute room: One day, starting on a mission, the pilots found the supposed bad-luck bringer camping on their 'chutes. As fast as she was thrown off one, she climbed onto another, until they tossed her out the door. That day the group brought down 22 Nazi planes. So Kitty was urged to stay, and in time supplied a corps of mascots



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Lt. Col. George B. Jarrett: the Axis fears him because he knows so much about their guns. His 150-mm. howitzer is German, World War I

Weapons Are His Hobby... and It's Helping Us Win the War

Army's gun detective solves secrets of enemy ordnance from junked artillery and shell fragments picked up on battlefields . . . Started as a boy by collecting souvenirs.

By

ALFRED H. SINKS

Photographs by WILLIAM W. MORRIS

"IF YOU know the enemy and know yourself, you need not fear the result of a hundred battles." This was written 2,500 years ago by the Chinese General Sun Tzu, in his great textbook on war.

DOWN at Aberdeen Proving Ground in Maryland, where the thunder of big guns, the scream of diving planes, rattle of machine-gun fire, rumble of tanks, and popping of land mines and booby traps give visitors the sound effects of an erupting battle front, a soft-spoken, sandy-haired, bespectacled lieutenant colonel with a stocky build and a studious air goes quietly about one of the most fascinating jobs that ever fell to a soldier.

As far as George Burling Jarrett is con-

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WORLD WAR I SOUVENIRS HE COLLECTED FOR FUN . . .



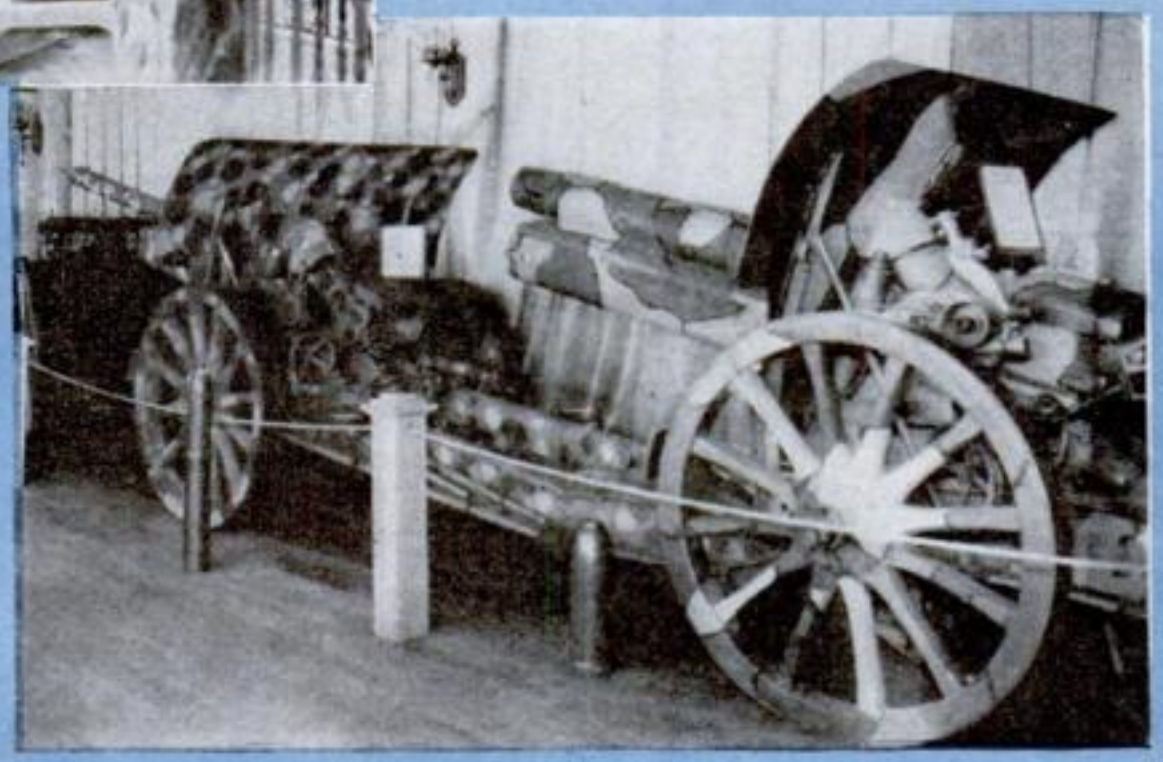
GERMAN PFALZ D XII flying over Hollywood after Jarrett helped its owner-pilot, Buck Kennell, of Paramount Studios, rebuild it. Jarrett had the necessary plans and data



UNIFORM of first lieutenant, German artillery, in World War I, draped on a dummy in Jarrett's museum on the Steel Pier, Atlantic City. Nearly ten million persons visited the exhibit from 1931-39



MARNE TAXI of the type in which French soldiers rushed to Joffre's support in the first Battle of the Marne. Jarrett bought it in 1931 from the driver, but later doubted its authenticity and had it junked



CAMOUFLAGED German artillery pieces as they appeared in his exhibition of World War relics on the Steel Pier. The larger piece (at right) is a 150-mm. howitzer of 1913; the smaller one is a 100-mm. gun of 1914, both used by the Germans

cerned, he is only following a lifelong hobby. He says frankly that for 28 years his consuming interest has been junk. Jarrett can take a blackened, twisted chunk of fragmentation and tell you just what kind of shell it came from. He can tell what kind of gun fired the shell, and give you all the specifications of that gun. The chances are he knows who made both gun and shell; where they were manufactured and in what year. The amount of information he can pull out of almost any piece of junk that may be picked off a battlefield would astonish a real-life Sherlock Holmes.

He has probably fired more different kinds of guns than any other man alive. And there certainly are few, if any, who have as intimate a knowledge of the tools of modern war.

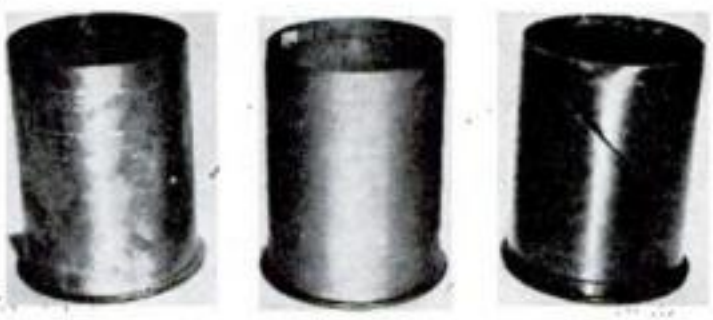
Many a decisive smash at the enemy thousands of miles from home can be traced back to the plain oak desk Jarrett occupies

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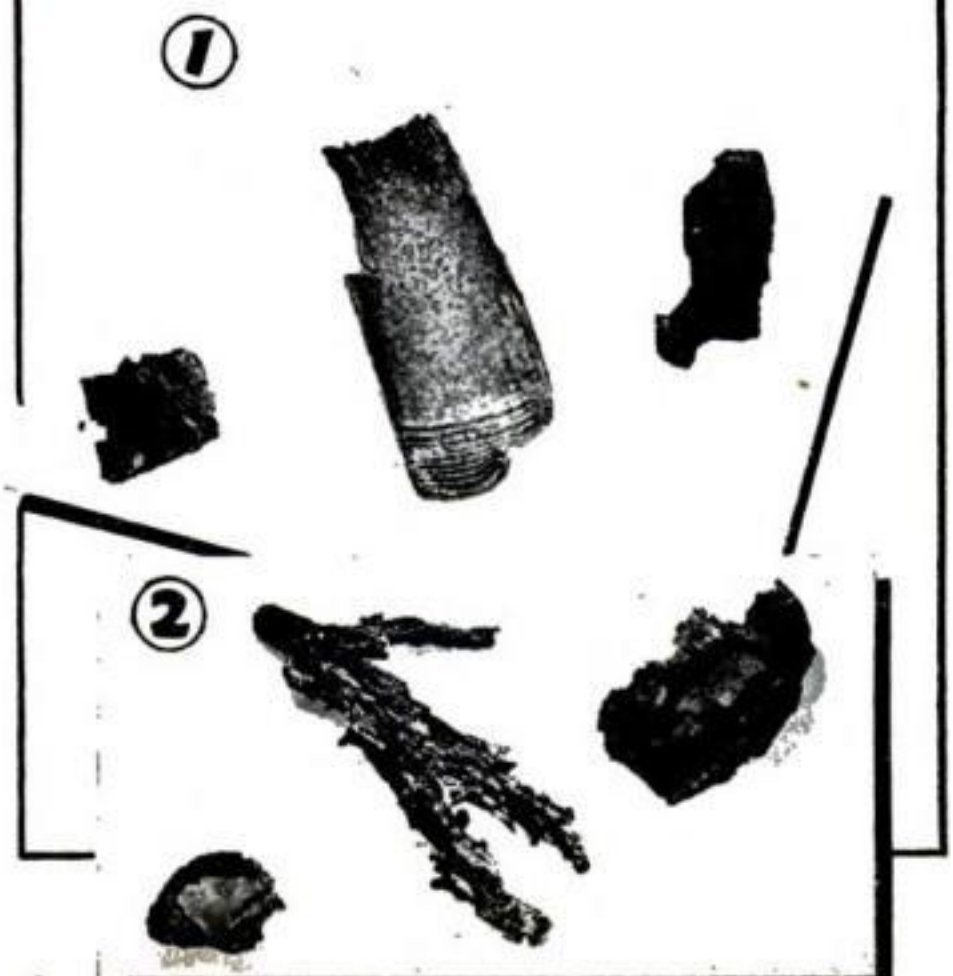
as head of the Foreign Matériel Branch of the Army's Ordnance Research Center at Aberdeen under Col. C. G. Eddy, chief of the Center. Out in the war zones, FMB maintains a corps of trained scavengers. They seize upon bits and pieces of dropped enemy equipment—anything from a sapper's knife with a new type of grip to a self-propelled fieldpiece with a new sighting mechanism or a tank tread with a new kind of bogie wheels. Jackals of war, they take samples of everything. Cartridge cases, ammunition feed belts—even buttons, buckles, and canteens are tossed into their rucksacks or piled on jeeps to be hauled away. All these they carefully sort out and classify. Each prize is taken apart and flown fast express to Jarrett at Aberdeen. There the weapons and other pieces of equipment are reconstructed, examined, fired, tested.

Half a dozen technical bureaus, including mysterious G-2 and OSS, pounce upon the

SMALL CLUES SHOW NAZIS ARE HAVING TOUGH TIME



How Nazi ammunition is deteriorating is revealed by the three 105-mm. light field-howitzer shell cases, above, picked up in North Africa. First, brass-plated steel (instead of brass); next, steel alone; third, twisted alloy. Their 75-mm. steel shells now break into large fragments (1, below) instead of more deadly, jagged splinters (2)





MULTIPLE ROCKET GUN as used by Germans. A 150-mm. mortar, it is electrically operated and fires explosive shells, smoke shells, and chemical rockets. Six rounds of 77-pound rockets are discharged in 90 seconds. Highly mobile, it's the "Nebelwerfer-41"



GERMAN MARK III TANK, which carries a 50-mm. cannon. Like the rocket gun, it was captured in North Africa. Much slower than American tanks, it is similar in characteristics to its big brother, the Mark IV, which is four tons heavier, carries thicker armor, and packs a big wallop with a 75-mm.

FIRING A GERMAN 88-MM. GUN at the Aberdeen Proving Ground. We don't use a three-piece barrel with enlarged chamber of this type because it is too dangerous for the gun crew. The Germans may be short of equipment for tooling full-length barrels



information gathered by the Ordnance Department's foreign matériel experts. Analyzed and interpreted, these reports keep our Intelligence abreast of the enemy's war production. Through a bit of *ersatz* substituted for a metal part, or a clumsy piece of workmanship, they show just how much the enemy's home front is suffering under our relentless pounding from the air. Sometimes they reveal sabotage among the slave labor corralled from occupied countries. Again they may tell of some brilliant new discovery of German scientists — to be passed on immediately as a challenge to our own research workers.

Analysis of the materials contained in these bits of enemy equipment often tells our bombing squadrons where to strike against the enemy's shipping, his railroads, his sources of raw-material supply. Not only such things as guns, bombs, and shells are important. A pair of waterproof pants taken from a captured German submarine commander in the Mediterranean told our Intelligence volumes about recent changes in Germany's chemical industry!

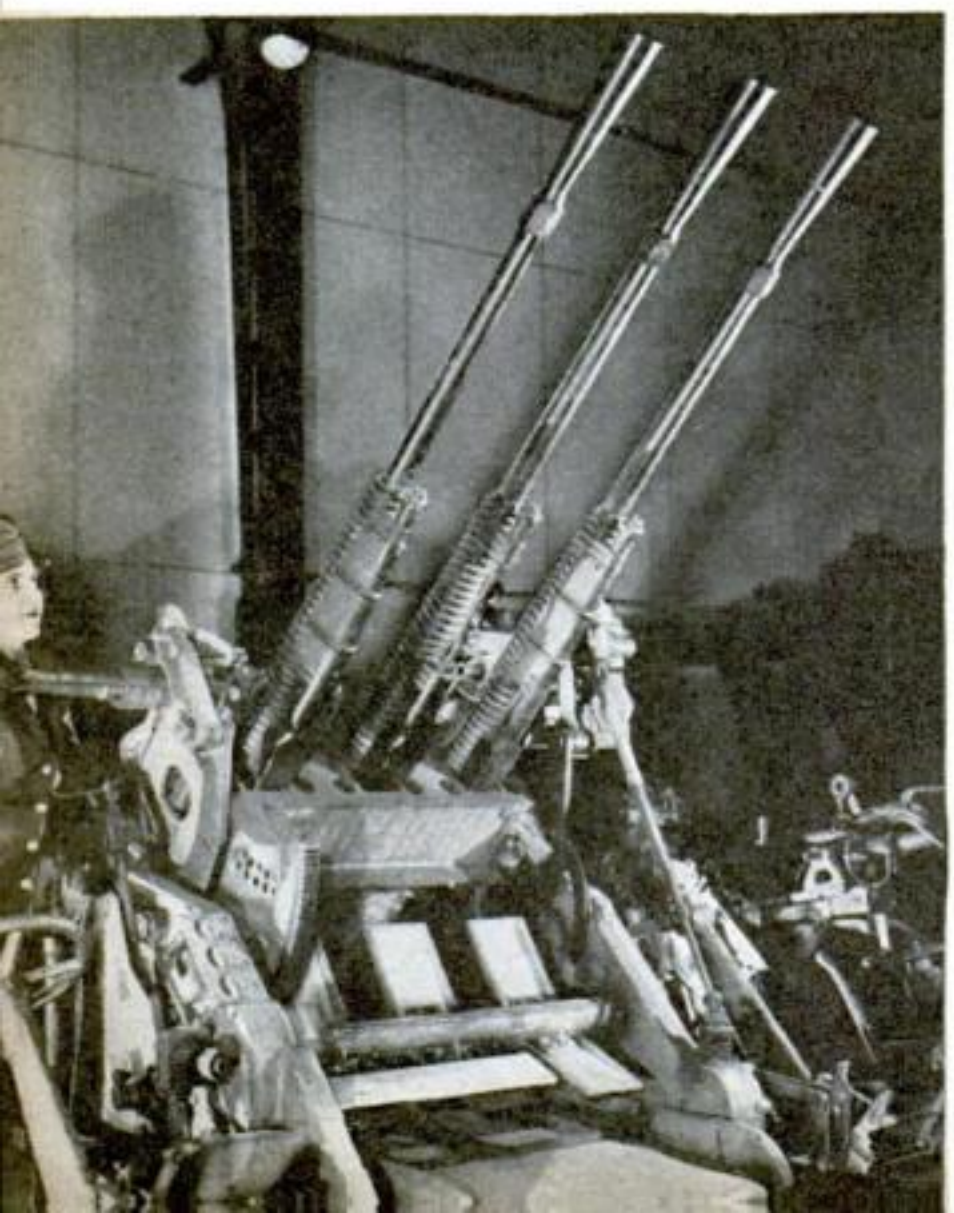
Little known except to the ordnance experts, FMB is one of the vital spark plugs in our war effort. According to Gen. G. M. Barnes, chief of the Technical Division of the Ordnance Department, it has saved endless time, countless soldiers' lives, and untold millions of dollars by giving us an accurate check on the enemy's firepower and a finger on the pulse of his war production.

But Jarrett is one man whose war job meant no sharp break with his peacetime interests. His hobby has simply grown up and gone to war. It has been shaped by the organizing genius of General Barnes and his staff into one of the most remarkable military intelligence organizations in the world.

Back in 1916 Jarrett was too young to fight, but he had a 16-year-old boy's natural interest in souvenirs of battle. Relics of Gettysburg crowded the walls of the Jarretts' Victorian parlor in Haddonfield, N. J. They had been left to Jarrett's mother by grandfather George C. Burling, who organized and led the Sixth New Jersey Volunteers in the War Between the States. So General Burling's red-headed, husky young namesake was delighted when he received a package from overseas. Mailed by an older neighbor who had left Haddonfield to join the French ambulance service, the package contained two buttons picked up at Verdun. One was from a German uniform, one from a French.

Those two buttons started what in the next quarter century became the most complete collection of the impedimenta of modern war. For the next 25 years he never stopped collecting, not even when his collection included a tank, half a dozen superannuated airplanes, a French field hospital unit complete with X-ray, a Renault military *camion,* French 75's, German heavy field howitzers, and enough uniforms and equipment to outfit 20 companies of troops in the fashion of all the nations that par-

ALTHOUGH YOU CAN'T VISIT IT, THE ARMY MAINTAINS ITS



GAS-OPERATED ANTIAIRCRAFT GUN taken from the Japs (at left). It's a poor copy of the French three-barrel Hotchkiss. Although a naval mount, the Nips were using it on land. It is rated only fairly effective against low-flying planes. Barrels are 58 inches long; the elevation is 75 degrees; traverse, 360 degrees

RECONNAISSANCE CAR—and it's not bad, either. This German vehicle, of 1½ tons, has speed, power, and low silhouette. Spare wheels, affixed to the center axle, give support on deep-rutted roads. Not armored



ticipated in World War I. Late in 1939 he was still hot on the trail of any prize that he had not yet succeeded in capturing. He had almost persuaded the Swiss Government to sell him one of their Schmidt-Rubin rifles when the outbreak of war stopped all further shipment of arms from Europe.

The quiet old Quaker town of Haddonfield, N. J., was inclined to look askance at young Jarrett's passion for the instruments of death. It was not long before his trophies filled every available inch on the walls of the young collector's bedroom. But the older Jarretts took alarm when "Burling's junk" filled the attic and began to spill over into the basement.

The Jarretts were not wealthy, and they were of no mind to advance hard-earned cash for such a useless-seeming enterprise as young Burling's. But he easily hurdled that obstacle. Summers he worked as a helper on a delivery truck. So single-purposed was he that he never learned to smoke cigarettes. Every spare bit of cash was saved for investment in the growing collection of "Burling's junk"!

In the summer of 1917-18 he managed to find a job in the yard of the New York Shipbuilding Company for the princely sum of $30 a week. Every payday, with his week's wages burning his pocket, he stopped at a certain pawnshop in Camden to look at a German army rifle, a Mauser that by some quirk of fate had found its way to South Jersey. Time after time he examined the gun with eager fingers. He has never forgotten the thrill he felt when he had finally saved enough money to buy it.

Nothing ever stopped Jarrett from going after any piece of ordnance that he needed for his collection, and he rarely failed to get it. He lost no time getting in touch with anyone, anywhere, who had a bit of ordnance to sell or swap. By using flattery on the Italian dictator he persuaded Mussolini to give him a whole collection of Austrian weapons captured in the last war. He got Crown Prince Wilhelm of Germany to contribute tokens of his own campaigns. Other collectors remember him as a shrewd trader who drove a smart bargain, but they declare he was always fair.

In 1922, after two years of college, Jarrett went to Europe, toured the battlefields, collected more choice items, and made friends who agreed to try to find still other pieces that he wanted. He went to work for an importing firm in Philadelphia, and the collection prospered. But by 1928 he was faced with a serious problem in logistics. The collection had grown to about 4,000 pieces. Six tons of "Burling's junk" crowded the eight-room house in Haddonfield. Jarrett decided that if the collection was to go on growing he would have to find some other place to house it. And it was becoming a too-expensive luxury. He would have to make it pay its own way.

He solved both problems at one stroke by persuading the owners of the Steel Pier at Atlantic City to let *(Continued on page 200)*

OWN MUSEUM FOR INTENSIVE STUDY OF ENEMY WEAPONS



JAPANESE LIGHT MACHINE GUN, 6.5-mm., type 96 (1936). It is gas operated, magazine fed, air cooled; has bayonet for in-fighting

ITALIAN LIGHT MACHINE GUN, Breda 6.5-mm., model 30. Although rated at 450-500, it fires in combat only 150 rounds a minute



GERMAN HEAVY MACHINE GUN, the all-purpose Solothurn, 7.92-mm., M34. Examining it are Maj. Gen. Charles T. Harris, Jr., who commands the Aberdeen Proving Ground, and Col. C. G. Eddy, chief of the Ordnance Research Center. Jarrett is head of the Foreign Matériel Branch

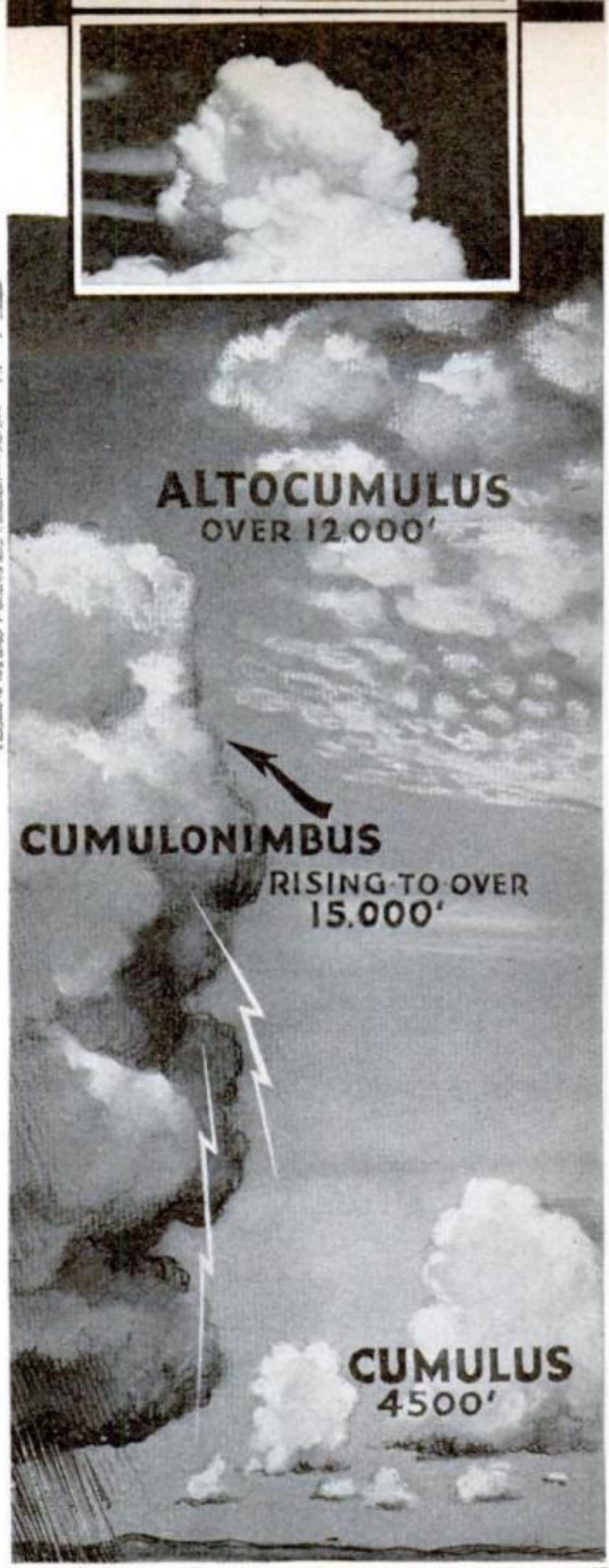


HOW TO READ CLOUDS

In this one easy lesson on nature's best signals you can learn to forecast the weather at a glance

By ERIC SLOANE

Author of "Clouds, Air, and Wind"



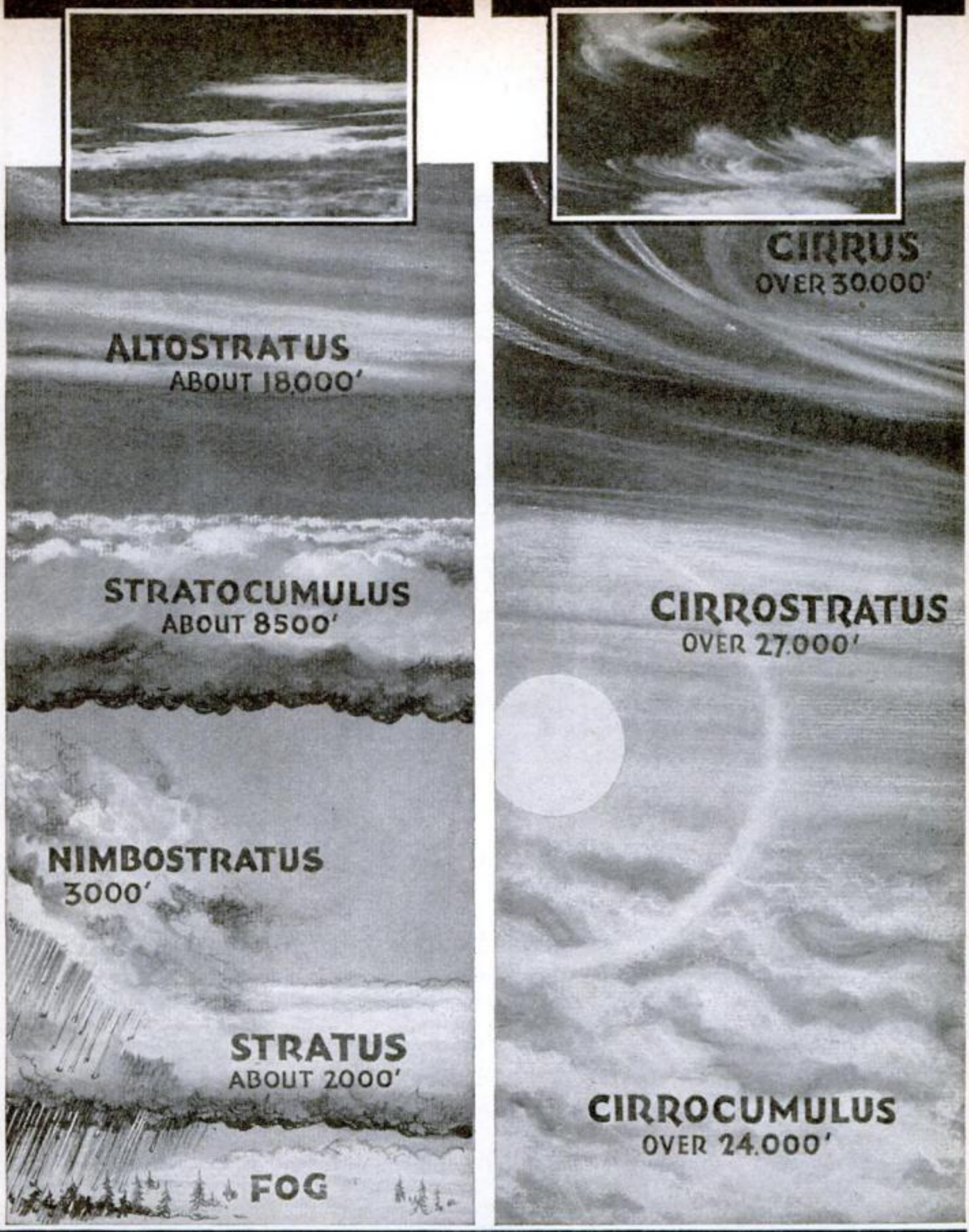
THESE ARE THE

THE beginner who would like to know something about clouds and what they tell about immediate weather prospects is usually discouraged by the jaw-breaking names given to them by meteorologists. Actually these terms are but simple combinations of a few basic Latin nouns and adjectives. Taking their names from their contours, the three main cloud forms are cumulus (accumulated, or heaplike), stratus (spread out, or extending horizontally), and cirrus (having a wispy curl-like formation). By combining these names with each other or with such qualifying terms as alto (high), fracto (broken), nimbus (head), castellatus (turretlike), and mammatus (bulbous), the beginner can equip himself with a fancy-sounding vocabulary adequate to describe practically any cloud formation he may find in the sky.

But hanging a fancy title on a cloud isn't enough. The trick for the amateur meteorologist is to recognize clouds as signals of approaching weather. Basically, a cloud is nothing more than a condensation from a warm body of air that either has risen of its own accord, or has been violently pushed upward, to a cooler level. By its shape and movement, however, it reveals a great many things about temperature, topography, and approaching or receding wind currents. Simple cumulus clouds, for instance, which are flat at the bottom and mountainlike at the top, are signals of good weather, for they mean that warm currents have risen leisurely in an undisturbed area and have then gradually condensed on reaching high

CUMULUS clouds are distinguished by their puffy heaplike formation. Warm air rising leisurely into a cold altitude usually produces a simple cumulus that is flat at the bottom and built up at the top. When this warm air is suddenly boosted skyward by an invading cold "front," however, it is likely to gather into an ugly-looking cumulo-nimbus, or thunderhead, that is a sure signal for a storm

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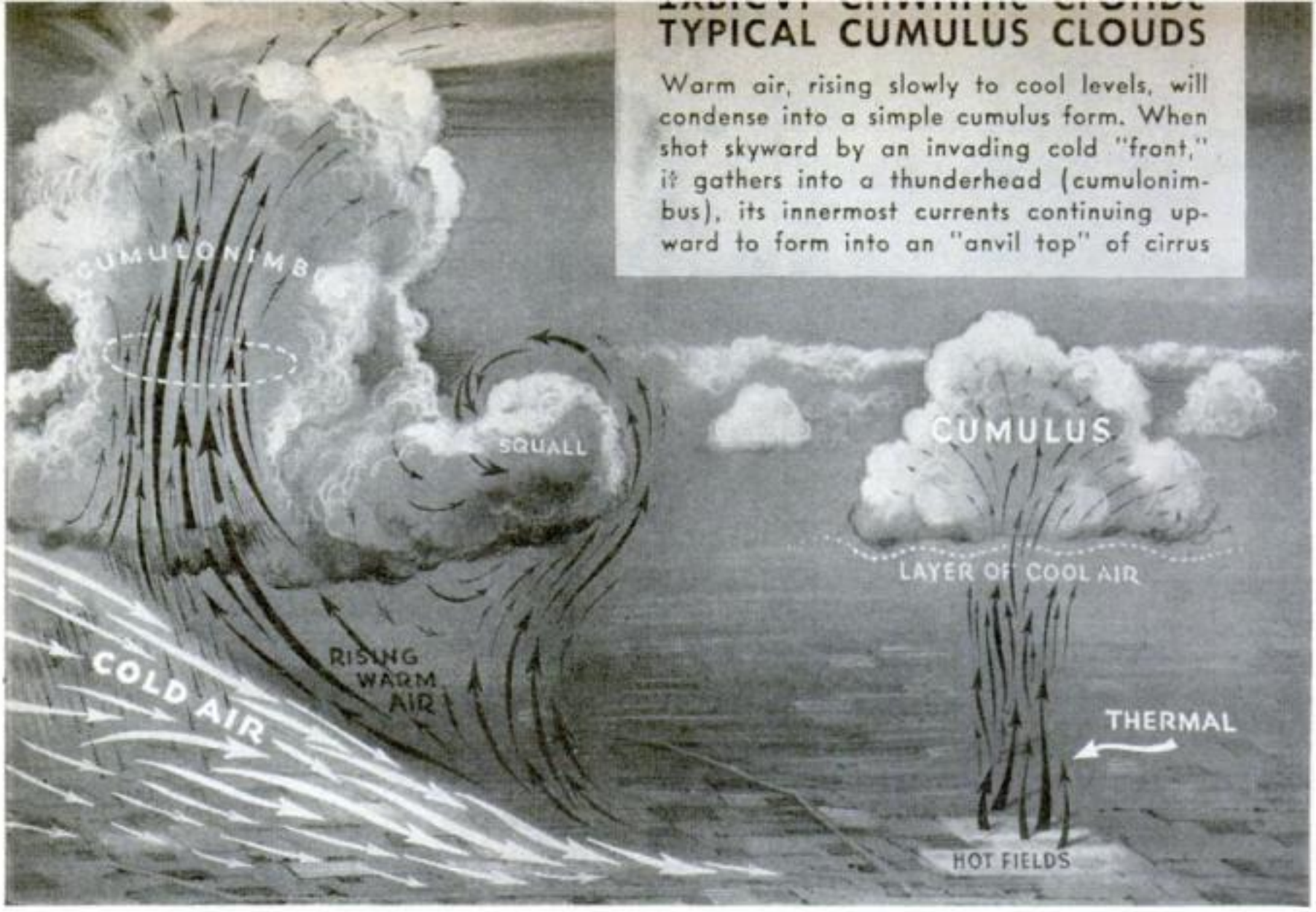


THREE PRINCIPAL TYPES OF CLOUDS

STRATUS, as the name suggests, is a comparatively straight layer of cloud that extends horizontally. It is often accompanied by rain. Like cumulus, it tends to form into a thunderhead (nimbus) as it rises. Familiar to virtually every airplane passenger is strato-cumulus, which, when seen from an altitude of about 14,000 feet, looks like a great wide-stretching sea of soft billowy cotton

CIRRUS is the high flyer of the clouds. Seldom found below 24,000 feet, it is composed of flimsy frozen vapor that the high winds have whipped into curly tenuous streamers. When a storm is caused by a cold body of air displacing a warm one, high rising currents will often freeze into the wispy tendrils known as "mares' tails." Moving ahead of the storm, these "tails" will indicate its course

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TYPICAL CUMULUS CLOUDS

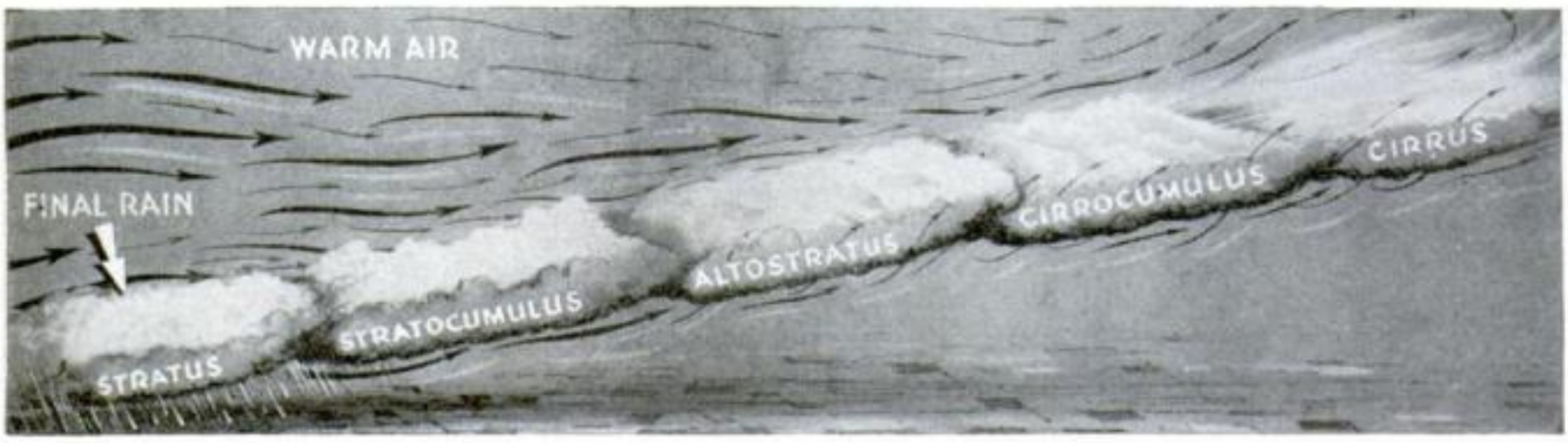
Warm air, rising slowly to cool levels, will condense into a simple cumulus form. When shot skyward by an invading cold "front," it gathers into a thunderhead (cumulonimbus), its innermost currents continuing upward to form into an "anvil top" of cirrus

altitudes. However, cumulo-nimbus, or a cloud formation that grows rapidly into a thunderhead and mounts to a summit, means that warm air has suddenly been tossed skyward by an invading cold current and that the surrounding area is in for a squall. Often a few inner currents of the warm, rising air will be shot up to the stratosphere where they will form into icy wisps of cirrus. Known as "mares' tails," this cirrus will push on ahead of the storm and indicate its prospective course.

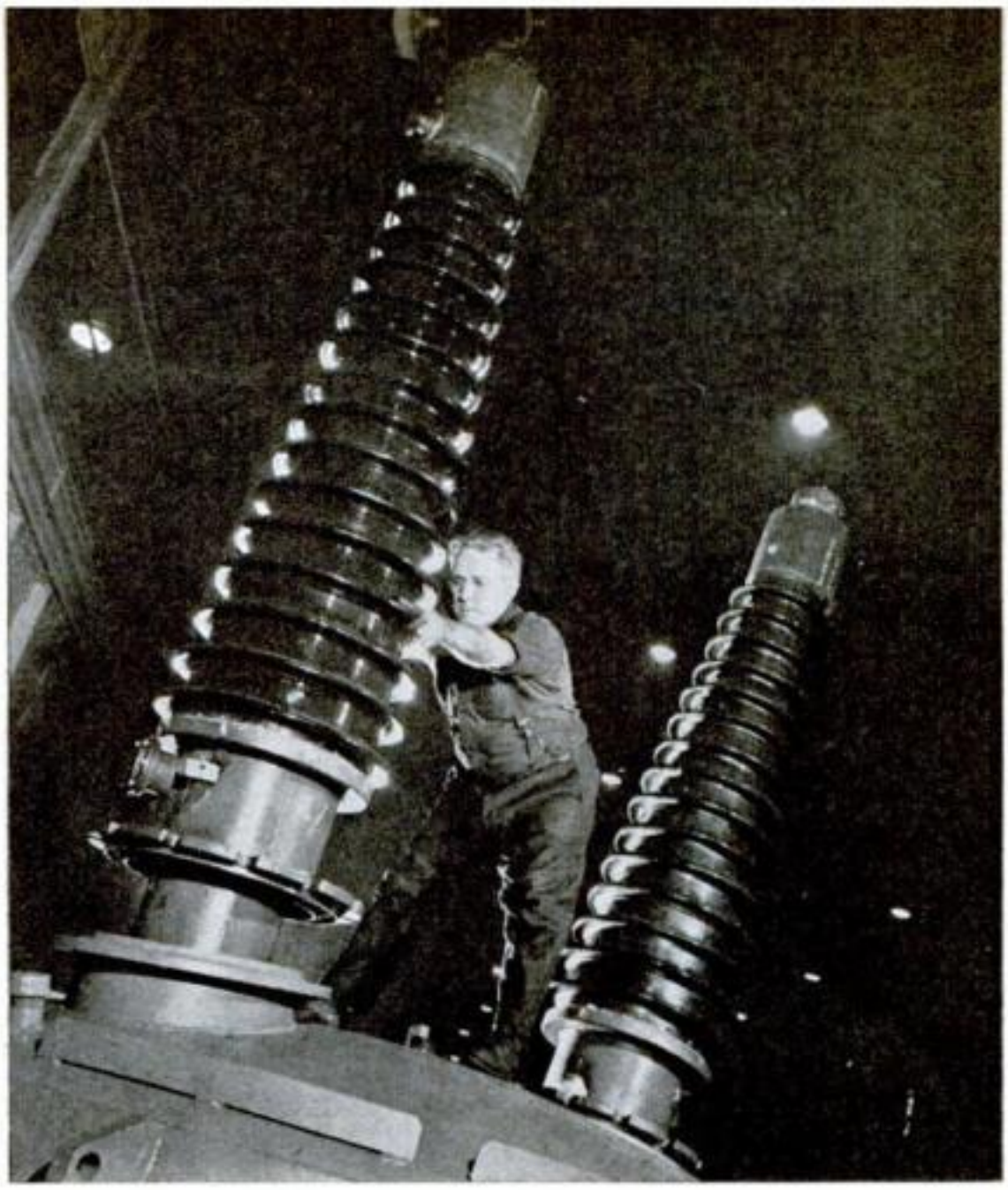
If you find a high, dull ceiling of milky cirrus, the chances are you are seeing the vanguard of an approaching body of warm air, for unlike an invading cold "front," which burrows under the warm air it displaces, a warm body of air invades by coming in "over the top." In other words, its front will begin at high cirrus and extend back and downward to low stratus—the latter formation usually being accompanied by rain.

Here, then, are a few of the most common ways in which nature signals the type of weather she is about to bring you: If on a summer day you find small cumulus clouds that don't tend to grow larger, you can be fairly sure that you are in for some good weather. If, however, you find a bank of cumulus that seems to be growing and building to a summit, you can start looking for rain, hail, and lightning. If you see banks of clouds extending east and west, and moving fast high in the sky, you can count on a cold snap. If a cloud layer on the horizon begins to form into turretlike shapes at its top, then you had better start looking around for shelter, for you are in for some heavy squalls.

Unlike an invading body of cold air which, in entering a warm area, comes ploughing in from below in a low spearhead that slopes away as it extends upward, an invading warm body of air comes in with its spearhead held high. In coming in "over the top," it presents a "front" that runs the gamut of formations, usually ending with the rain-bearing stratus

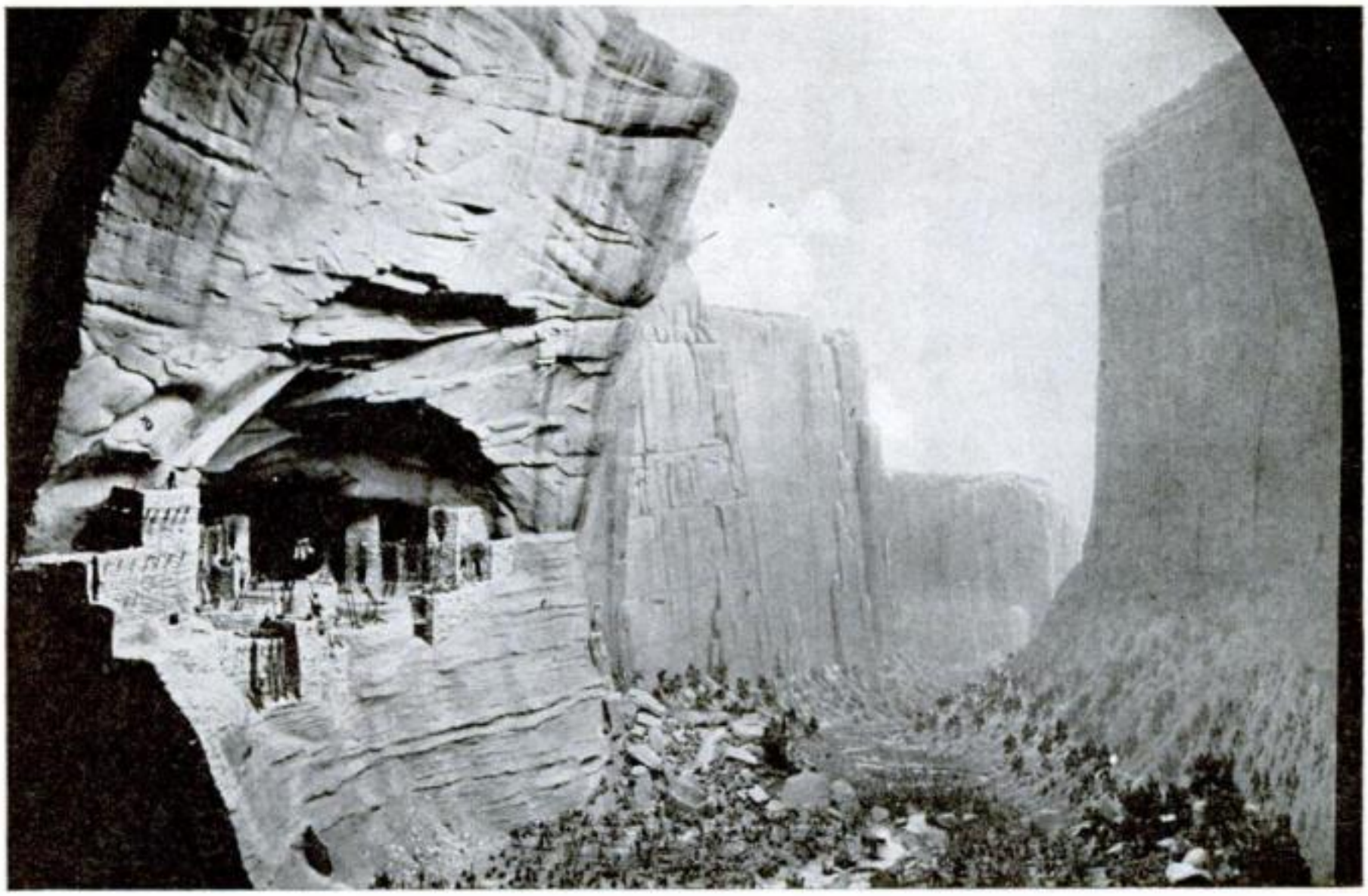


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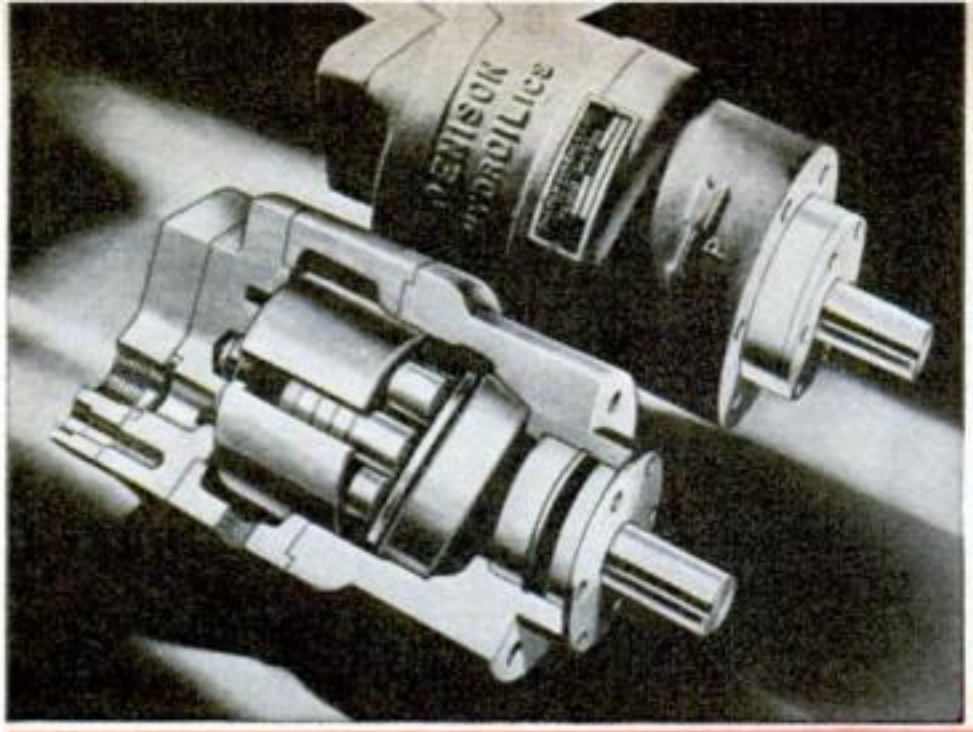


MAMMOTH PLUGS in the top of an oil circuit breaker are a part of the switch that guards the flow of 230,000 volts of electricity into a new war plant of the Northwest. Inside the tank is a disconnecting device that shuts off the power in one twentieth of a second when a short circuit occurs. More than 5,000 gallons of oil quench the blue-hot electric arc created when the switch is opened. The six-foot piles of porcelain saucer insulators on the upper half of the plugs prevent high-voltage electricity from flashing over between the tank and the transmission line. The plugs, known as condenser bushings, are shown being prepared for a test at the East Pittsburgh works of the Westinghouse Electric and Manufacturing Company, where they are being made ready for shipment and installation.

HOUSING PROBLEM in Arizona 700 years ago was solved by Indians in the Canyon del Muerto. The Chicago Natural History Museum has demonstrated how in a diorama model of a cliff dwelling placed in the new archaeological hall devoted to American Indian civilization before the coming of the white man—prior to 1492. Archaeological evidence indicates that the cave was occupied by the Indians about 1250 A.D., and abandoned some 50 years later on account of drought and a military defeat. The cornfields on the canyon floor were reached by a zigzag path cut in the cliff.

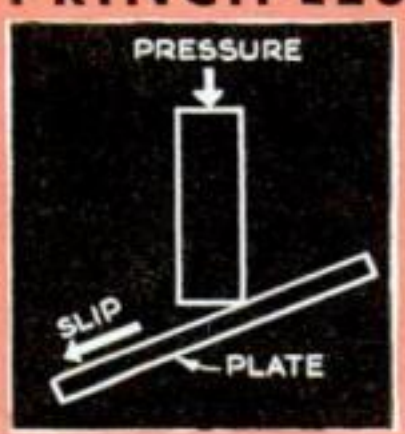


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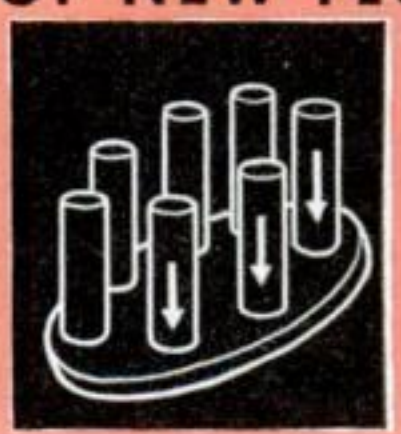


FLUID MOTORS, driven by oil pumped through them, give precise movements. For example, they turn and stop "indexing" tables for high-speed presses that load war shells. At left, views show outside and inside of new Denison Engineering Company model. Few moving parts assure long wear, as suggested in simplified sketches illustrating the principle. This type of drive is said to permit instant starts, stops, and reversal without damage.

PRINCIPLES OF NEW FLUID MOTOR



Imagine a piston pushing down on an oiled and tilted plate. Piston slips downhill



Now arrange seven pistons, some pushing down under oil pressure. Pushers slide down



Enclose pistons in cylindrical guide, and the cylinder will turn as shown by the arrow



Fix drive shaft to cylinder; you have a fluid motor. Some pistons push; others spill oil

ARC WELDING, with metal applied layer on layer, is being used with General Electric electrodes to build up railroad car wheels worn down by the punishing grind of war transportation. Heavily loaded trains are resulting in unusual wear and tear on the rolling stock, and the difficulty of obtaining replacement parts makes it necessary to repair wherever possible. The car wheels, after being preheated to 350 degrees Fahrenheit with a blowtorch, are built up with a bead of metal, after which they are finished to their original dimensions and, for practical purposes, their original condition.

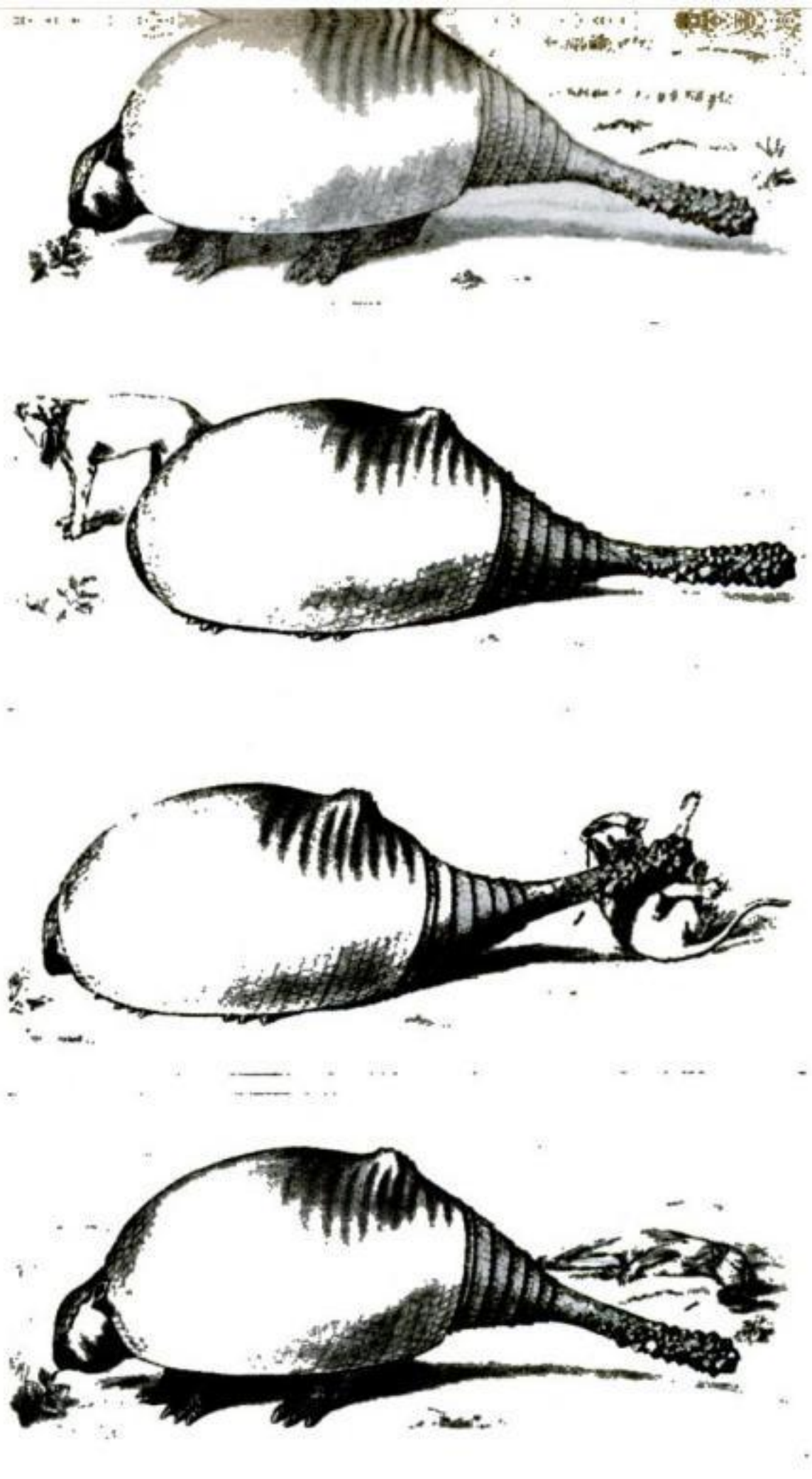


Before, during, and after the resurfacing of a railroad car wheel. Repairman checks to see extent of wear; wheel is built up by arc-welding process; inspector gauges new lathe work





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"GUNBOAT GLYPTODONT accepts challenge of Battling Sabertooth, and kayoes him in fourth round." Thus, three million years ago, some mid-Pliocene sporting editor might have headed his blow-by-blow description of the fight. These pictures by John Conrad Hansen are part of a paleontological exhibit in the Chicago Natural History Museum, and show a huge tortoise-armadillo ably coping with a sneak attack by a saber-toothed tiger. Covered by a shield of bony armor, in some places more than an inch thick, this glyptodont was further armed with a heavy clublike tail capable of dealing a crushing blow to an attacker. The largest of these animals attained over-all lengths of more than 10 feet.

The first picture of the series shows the glyptodont, a strict vegetarian, grazing on a bit of herbage while the sabertooth approaches warily. As the cat draws near, the armored monster draws in his head and bides his time. When the sabertooth circles around to the rear, he gets too close, and the heavy spiked tail goes into action, knocking the attacker cold. Having thus disposed of his enemy, the tortoise-armadillo continues his interrupted meal. Scientifically speaking, this armadillo is known as *Eleutherocercus;* the sabertooth as *Thylacosmilus.*



TELEGRAMS IN CHINESE are being speeded for wartime communication between four of the most important cities of China by Telefax apparatus built by the Western Union Telegraph Company. Previously, the Chinese system of telegraphing has involved using a code number for each of the 9,000 characters employed in writing. On the receipt of such a telegram, it must be decoded by turning the numbers back into their corresponding characters. Such telegrams occasion delays that hamper the war effort. Since the Telefax apparatus electrically transmits in facsimile whatever is written on paper, there is no loss of time in either sending or reading the message. At left, a Chinese telegraph employee examines a test message.

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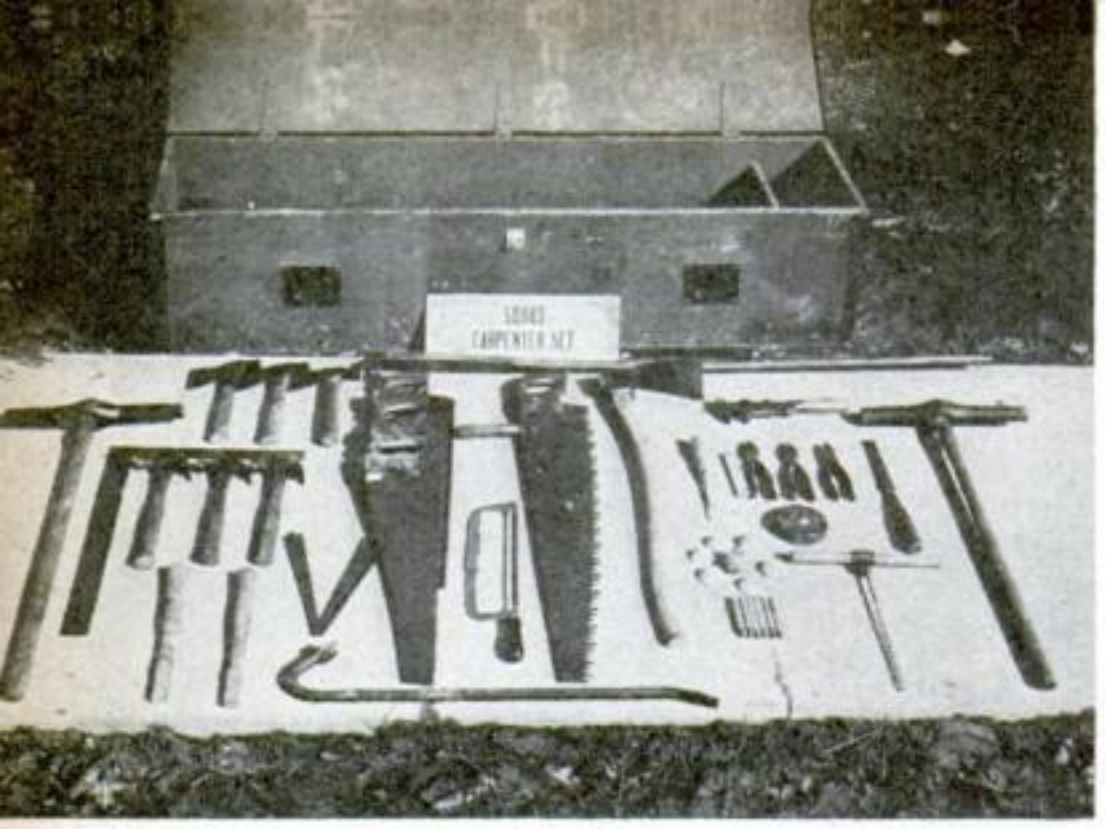
Combat Tools

FOR ARMY ENGINEERS

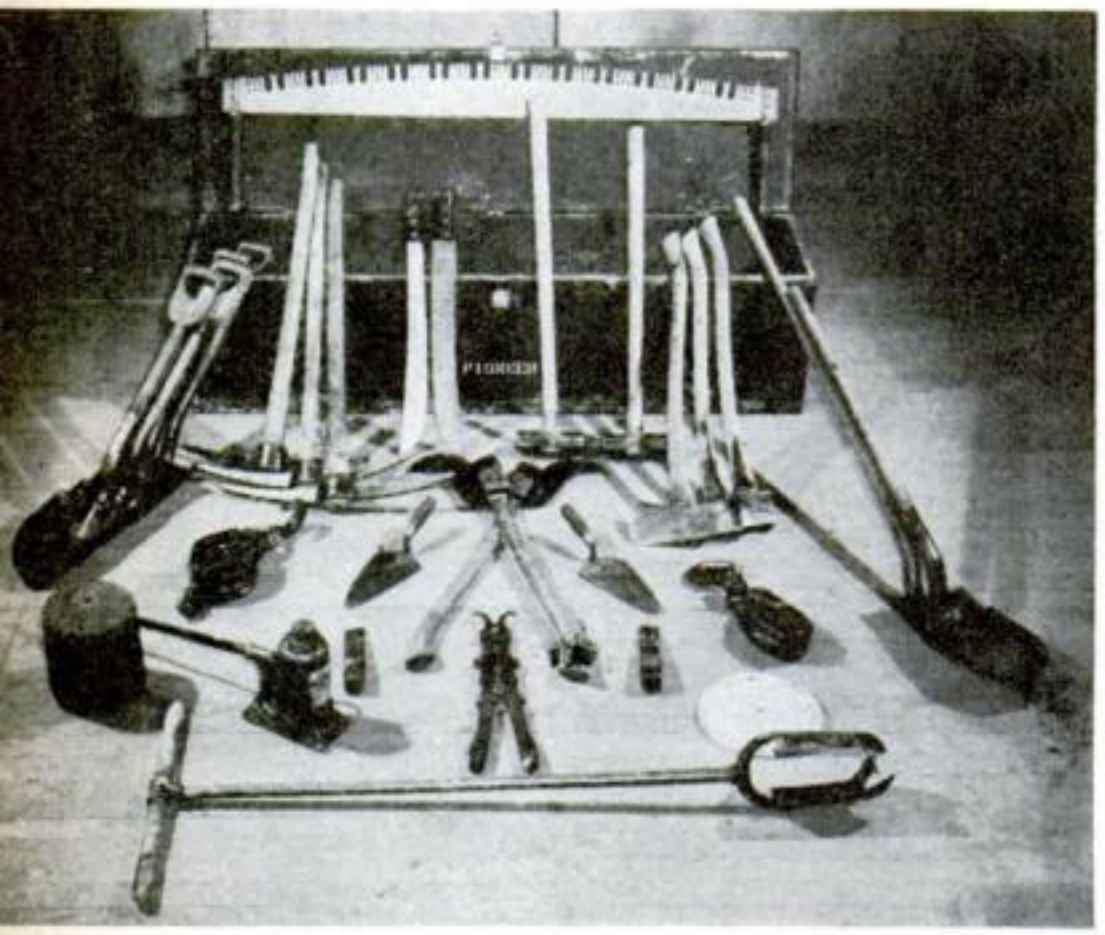
PRACTICALLY any kind of job is possible to the combat squads of the U. S. Army Corps of Engineers equipped with their three new portable tool sets illustrated here. They include tools for building roads, bridges, barracks, and airfields; for digging foxholes, trenches, and drainage systems; for stringing telephone lines, repairing railroads, and erecting camouflage nets and road blocks. The engineers are equally prepared to demolish and wreck, and, if need arises, to fight.

The sets emerged from experiments at the Engineer School, Fort Belvoir, Va., where officers and men of the engineer battalions are being trained. Most of the tools are familiar to persons having knowledge of construction work, but some uncommon ones have been added. For instance, there is the brush hook, a strange-looking tool resembling an ancient weapon. At the end of a wooden handle is a sharp curved blade, ideal for cutting through jungles such as those in New Guinea and the Solomons.

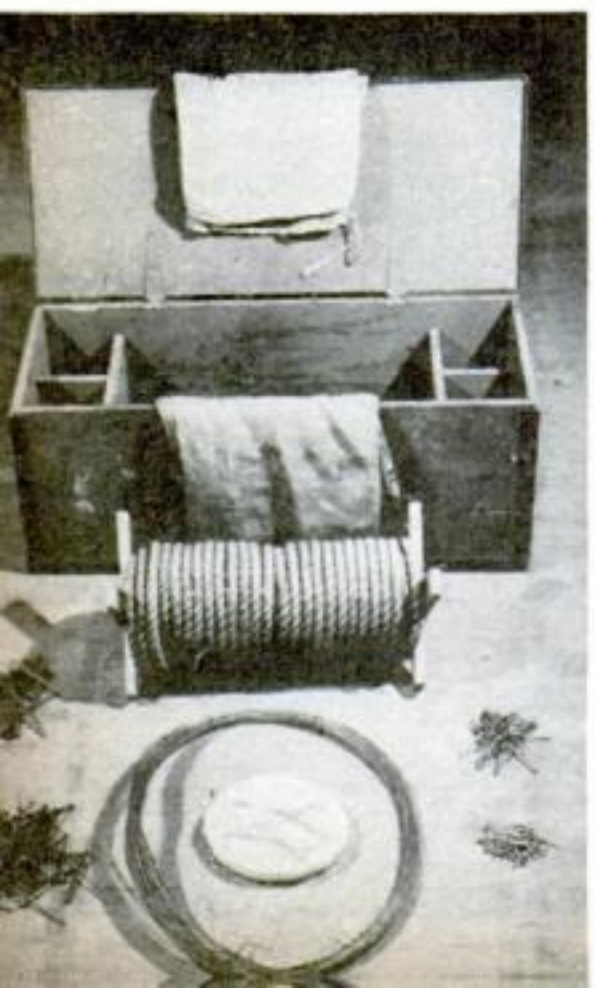
The units of this equipment are known as the Pioneer Set, the Auxiliary Set, and the Carpenter Set. Two or four men are detailed to carry them, depending on the distance. Every squad has two of the sets, and each platoon carries supplementary sets and extra tools.



CARPENTER SET of tools is here displayed to show axes, saws of several kinds, pinch-point crowbar, adz, monkey wrench, spike maul, steel square, foot rule, claw hammers, side-cutting pliers, framing chisel, gooseneck wrecking bar, and a few small items such as hacksaw blades, metallic tape rule, chalk, chalk line, and six red and blue crayons



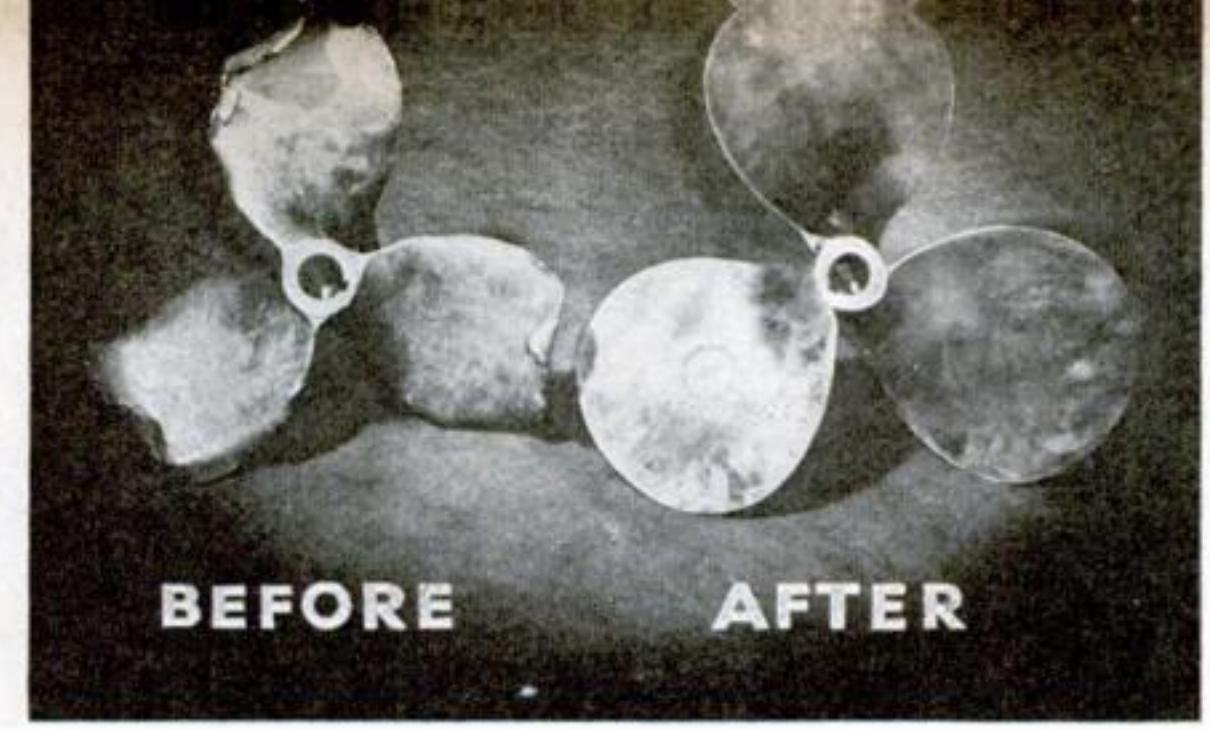
PIONEER SET includes a five-foot crosscut saw, shovels, picks, machetes, sledge hammers, axes, brush hooks, blocks, post-hole auger, and a 12-ton hydraulic jack. Brush hooks, seen crossed at the center of the picture, are used for cutting through South Sea jungles



AUXILIARY SET, shown at left, is used in conjunction with the Pioneer Set, pictured above. Normally it contains 300 feet of ¾-inch rope, a roll of 16-gauge wire, 105 pounds of nails ranging in size from 8-penny to 60-penny, and 30 burlap sandbags. It is carried by two or four men

Combat squad member shapes log with adz from Carpenter Set. All tools in sets come into use as engineers build, repair, or destroy in battle areas. A common use for the adz is in making railroad ties for wrecked tracks





Propellers that look like hopeless wrecks, damaged by being run on a beach or through contact with rocks and logs, are renewed by expert treatment. At left is a seeming piece of junk brought in for repair; at right is shown a similar one that has been reconditioned



1 The bent blades are hammered back to the correct angle on this "pitch block," so that they take the proper "bite" of the water

Invasion-Scarred Props Rebuilt

A HIGGINS landing boat has fulfilled its mission. Roaring in from the sea, grating to a stop on an inhospitable shore, it has unloaded cheering men who form the spearhead of an American invasion force. What matter if brutal treatment has twisted and torn its propeller, so long as the beachhead has been secured?

But the chances are that this same propeller will see combat duty again. In the hands of expert craftsmen, an apparently hopeless wreck will be restored to its original pitch, built up where its bronze has been torn away, and ground and polished until it is as good as new. Accompanying photographs show how the exacting work is carried out in the New York shop of Oluf Mikkelsen, one of the firms whose propeller-reconditioning facilities are being devoted entirely to Government service for the duration.



2 An important step in the process of reconditioning a damaged propeller is building up lost metal with the aid of oxyacetylene welding torch and bronze welding rod. A slight excess of metal is added to allow for grinding

3 In grinding to size, the original thickness and other dimensions of the propeller are restored by coarse and fine grinding wheels, followed by prefinishing to close measurements on an emery wheel



4 The like-new appearance of reconditioned propellers is accomplished by the use of buffing and polishing wheels, which impart to the blades their final smooth and mirrorlike finish



Nature Stokes the Furnace

Iceland's hot springs will be tapped for the heat and power to create an arctic paradise.

By HAROLD O. WHITNALL, Sc.D.
Colgate University

AFTER the war ends, Iceland is to become a garden spot of the world. Utilization of its many hot springs will transform a region of snow and ice into a chain of large hothouses where grapes, melons, tomatoes, cucumbers, and other fruits and vegetables will grow in abundance. Every Icelander's table will offer products now known only through importation.

It didn't take the American doughboy long to learn from the girls there how to do washing in hot waters bubbling from the earth, or the easy way of brewing a pot of tea with steaming water from an outdoor pool. Once in a while he had a taste of a fresh tomato grown under the glass of a small greenhouse. If he was lucky enough to spend a week end in one of the better homes, apartments, or hotels in Reykjavik, the capital, he found his room heated by water from scalding springs.

The abundance of these naturally heated waters impressed the forward-looking Yankee mind. If a few tomatoes could be grown in small hothouses, why couldn't they and other products be grown on a large scale? And if a few buildings could be heated by the waters from hot springs, why not an entire city? This cheap and inexhaustible source of heat was not being used to the extent it should be, especially in a cold land whose only fuel is dried turf, bits of dwarfed, scraggly trees, and a small amount of expensive imported coal.

American money came in, and this year will see the completion of pipe lines which will enable all houses in Reykjavik to be heated with hot-spring water. American inventive genius visualized the building of many large hothouses, where luscious fruits and vegetables could be raised to vary the monotonous diet of potatoes, cabbages, rhubarb, and a few small fruits and berries. Already ambitious young Icelanders are in the United States studying hothouse horticulture and obtaining estimates on glass and other greenhouse materials.

Iceland is a strange region of ice and fire. One eighth of its 40,000 square miles is mantled with glaciers, and a much larger



STEAM-DRIVEN TURBINE PROVIDES ABUNDANT POWER

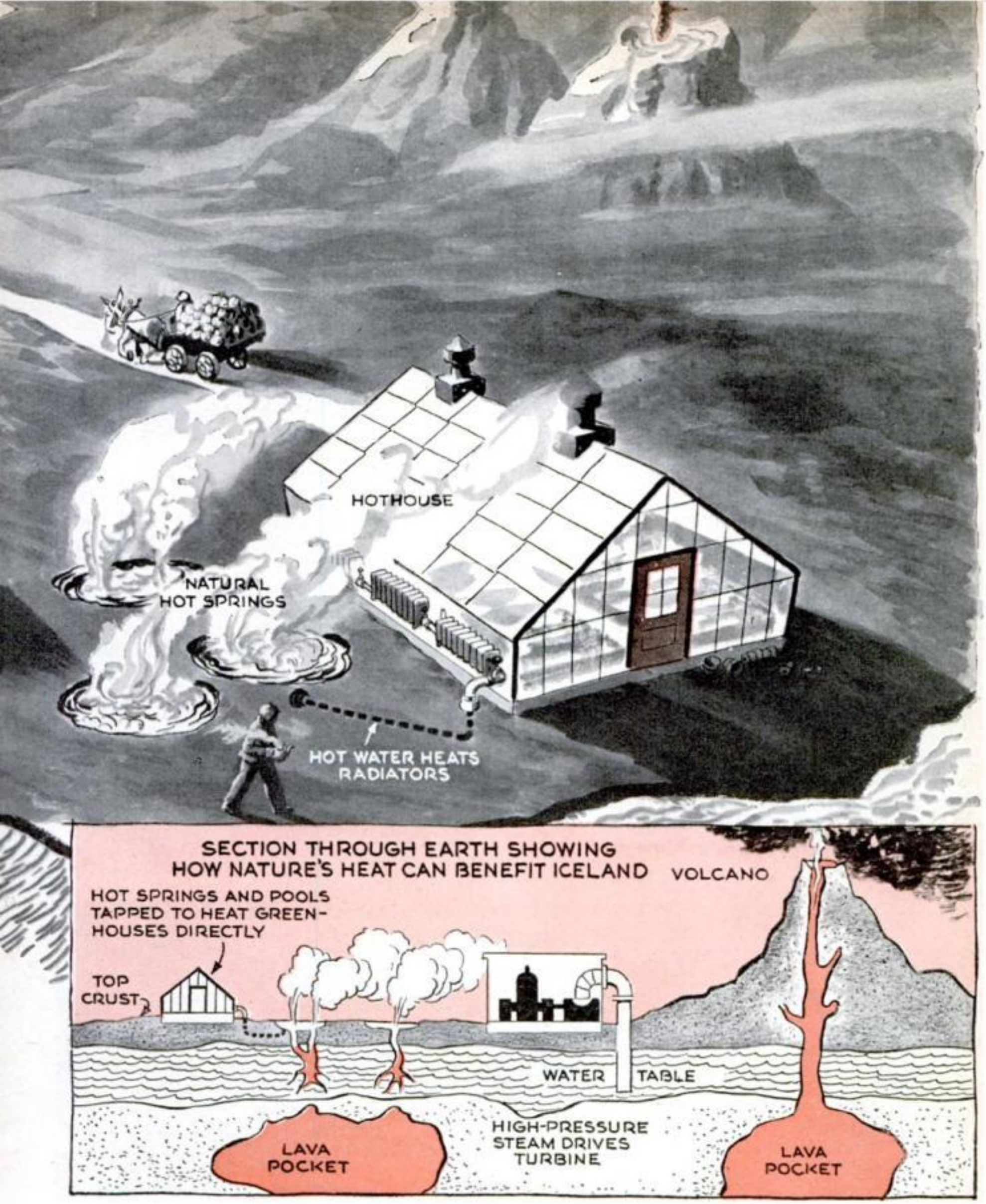
area is snowbound for most of the year. But beneath the cold surface rocks lies thick, hot, molten matter. From time to time these subterranean pockets filled with melted rock have been squeezed and their contents forced upward. Some of this white-hot fluid has broken through the surface and spread lava over the land through volcanic vents, of which there are over 100; some 20 have been active in modern times.

Many masses of the melted underground rock have never reached the surface, but have been checked in their rise and now lie buried at no great distance from the surface, radiating a tremendous amount of heat into the adjacent crust. As water comes into contact with this intense buried heat, its temperature rises sharply, and it finds its way to the surface in the form of steam jets, hot springs, and geysers.

Although hot springs are not unusual phenomena, those of Iceland are remarkable for their singular freedom from disagreeable solutions of sulphur, iron, chlorine, and other impurities; furthermore, they carry little sediment. These qualities permit their use in outdoor swimming pools, in washing clothes, and in plumbing systems.

The springs vary from tepid pools to reservoirs of piping-hot water with temperatures

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at the boiling point. But that is only the beginning of the story. Geologists are surveying the areas where the springs break through the surface, looking toward the drilling of new openings at greater depths which will tap hotter waters.

When the groundwork for making Iceland a northern hothouse is completed, the economic status of the island will be greatly improved. With unlimited live steam and hot water piped from abundant hot springs, greenhouses can be heated and maintained at any temperature much more cheaply than those in any other country in the world, and this in a land where winters are long and summers short and cool. Not only will the inhabitants get new food; England and the Scandinavian countries will eagerly await the luscious fruits and fresh vegetables grown by means of volcanic fires.

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ROAD CLOSED — Detour 20,000

With the Japs astride her famous Burma Road, China gets supplies by air transport over the hazardous near-Himalayan "hump."

By

ALDEN P. ARMAGNAC

STARTING from India instead of from Japanese-held Burma, giant American cargo planes replace earthbound trucks to carry vital military supplies to China. Latest figures reveal the amazing fact that the air route now surpasses the famous Burma Road at its peak of monthly capacity.

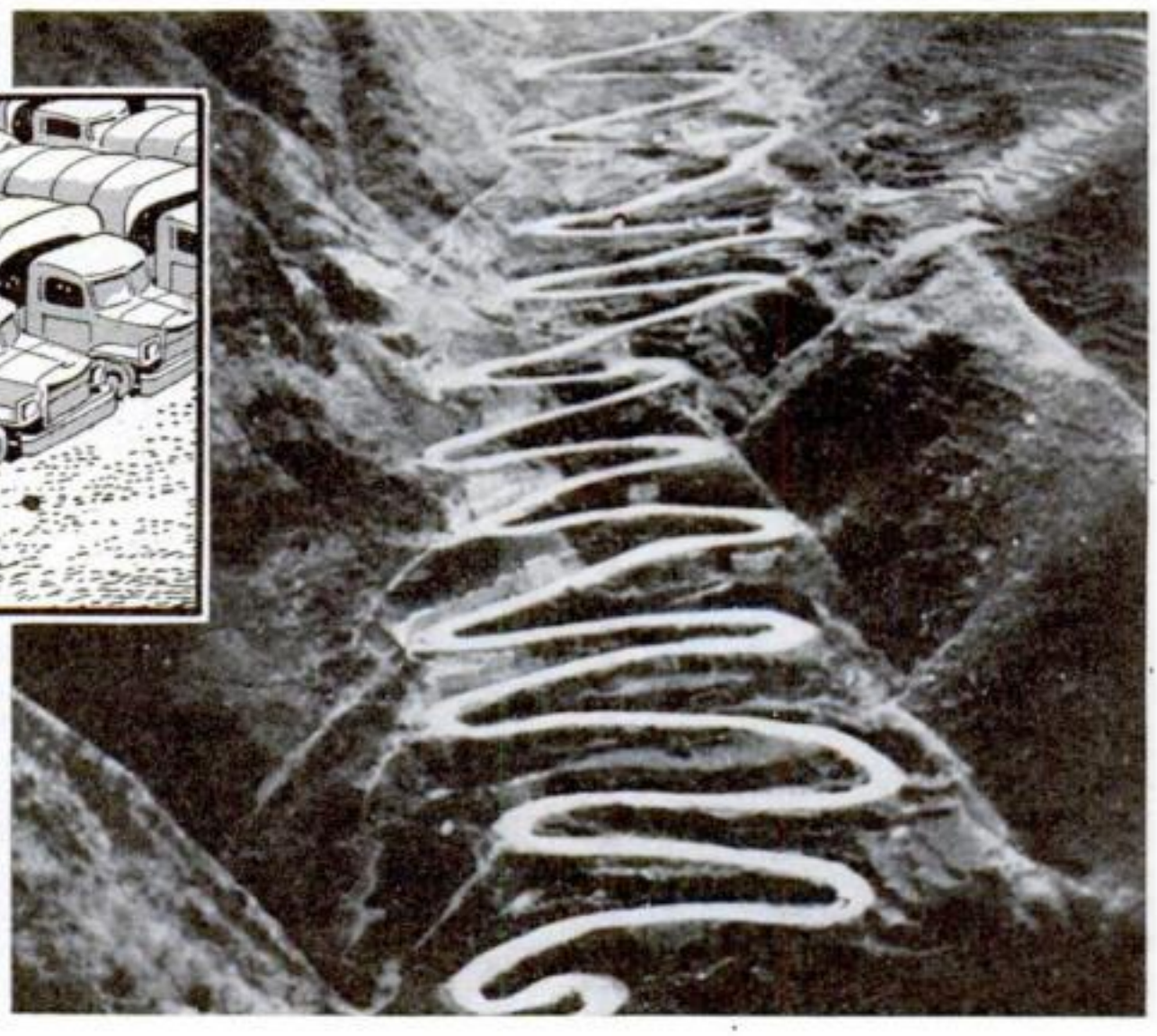
Exploiting its temporary command of the Far Eastern seas after Pearl Harbor, Japan has tried desperately to isolate China from Allied aid—and failed. And now the turning point has come.

From India's port of Calcutta, a railroad extends to the extreme northeastern corner of the empire, in the province of Assam. At this jumping-off place, American flyers have established a group of airfields. Hardly had the Burma Road been cut by the Japanese when daring airmen pioneered a flying cargo route from these bases over the mountainous "Burma hump," amidst snow-capped peaks 20,000 feet high, to Yunnan, China. They began with rickety old DC-3's, better fitted for the scrap heap than for the world's most dangerous airway. Then twin-motored C-46's, and sleek four-motored Constellations with pressurized cabins, began to arrive. Flying day and night, they now are declared to exceed the traffic handled by La Guardia Field, New York City's great airport. The air trail remains as hazardous as ever—one pilot who reported sighting "a cloud with a rock in it" came in with half a tail—but special rescue crews stand by to go after overdue flyers, who may have had to bail out in the inhospitable terrain. Into China the cargo planes bring bombs, jeeps, gasoline, plane motors, spare parts, small arms and ammunition, and even artillery and 2½-ton trucks. They return with Chinese tungsten and other strategic materials.

Military observers dispel any illusion that China, even now, receives enough arms to meet all her needs. The "aerial Burma Road," an emergency step in the right direction, many soon be supplemented.

At this writing, Allied troops are fighting their way through northern Burma toward China. Behind them, starting at Ledo, India, engineers are hacking out a new highway. Currently it serves simply as an "invasion road," bringing up supplies to the troops advancing ahead of it and on its flanks. But eventually, the Ledo Road may be linked to the Chinese-held portion of the Burma Road.

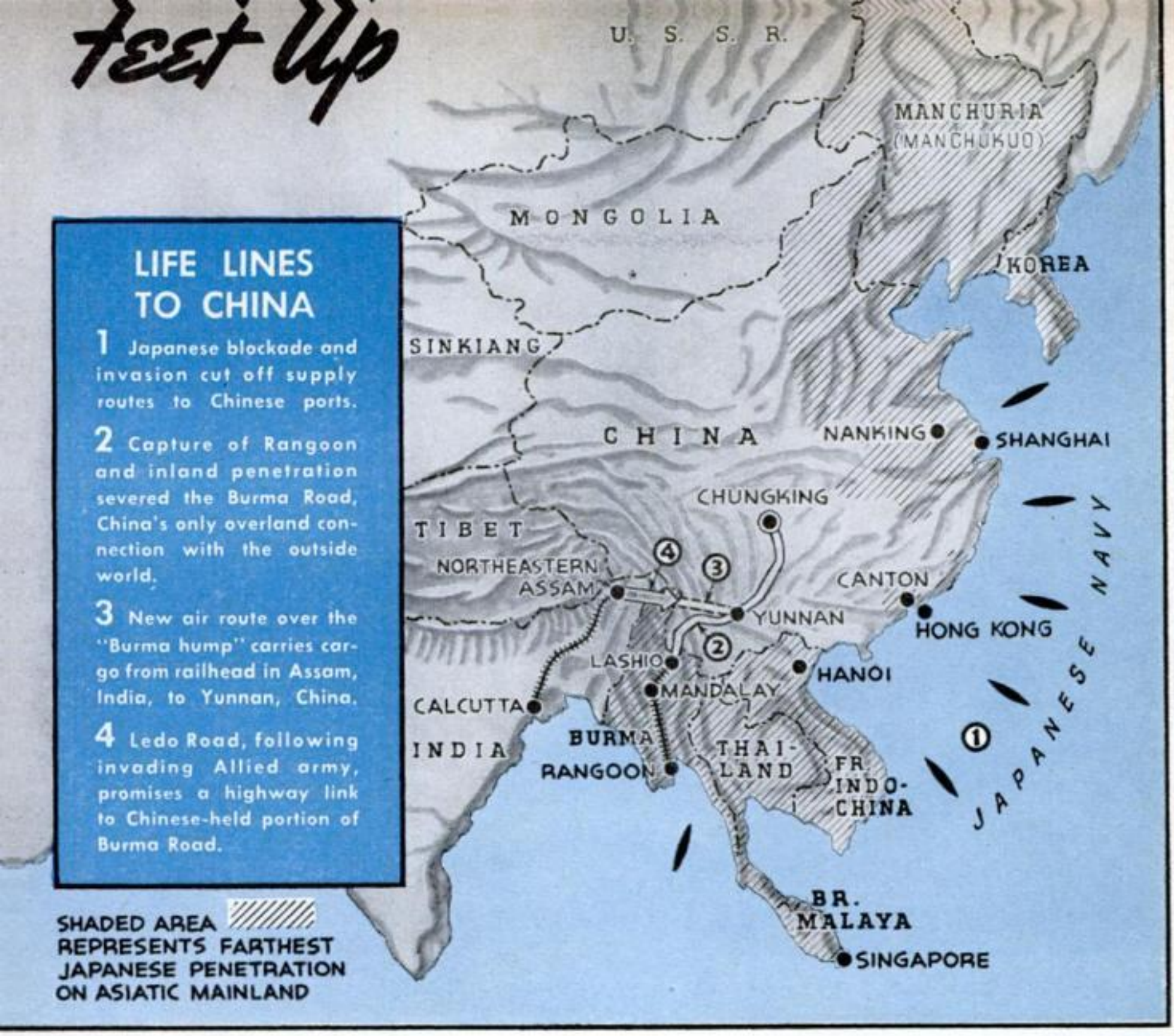




TRUCKS carried 15,000 tons of freight a month into China over the Burma Road when that famous highway was open and carrying its peak capacity. The photograph at the right shows a ladder of hairpin turns with which the Burma Road snakes its way across near-Himalayan ranges

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Feet Up



LIFE LINES TO CHINA

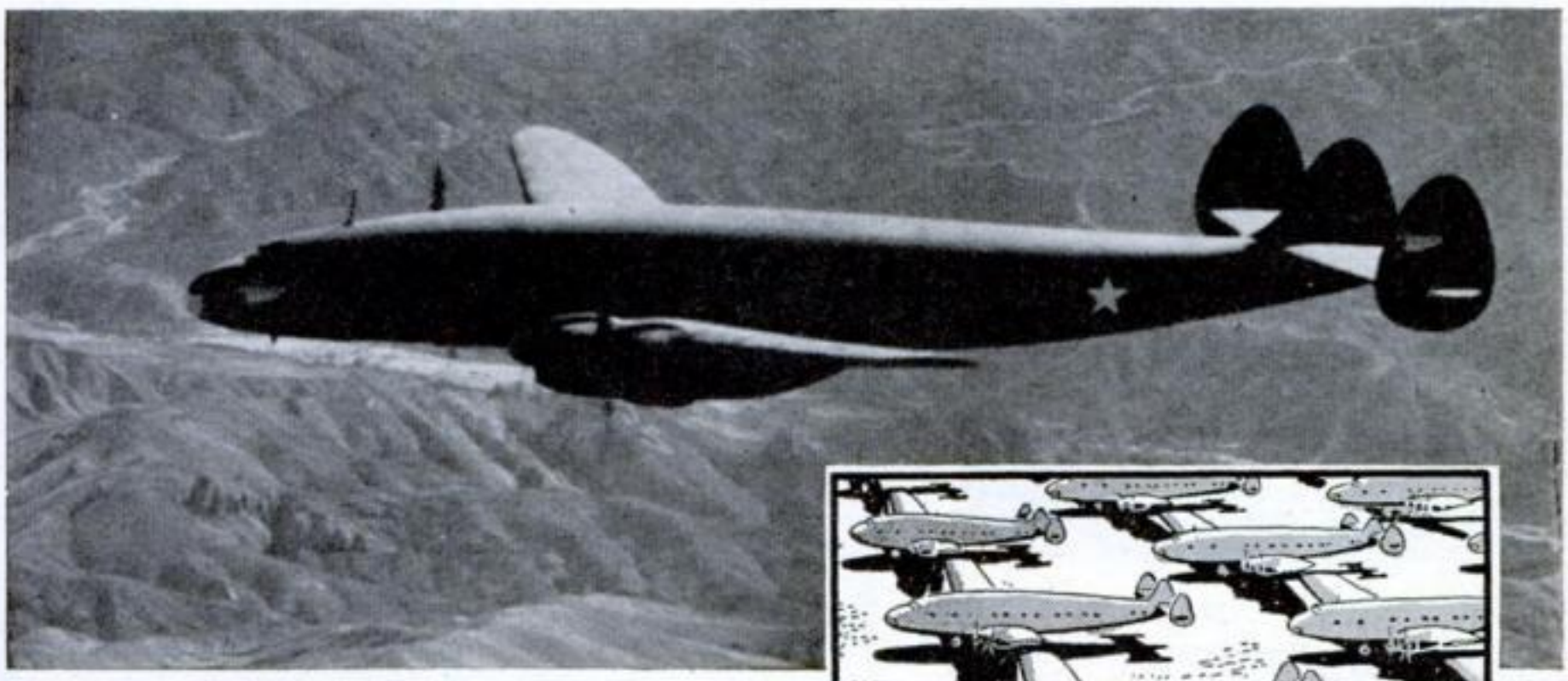
1 Japanese blockade and invasion cut off supply routes to Chinese ports.

2 Capture of Rangoon and inland penetration severed the Burma Road, China's only overland connection with the outside world.

3 New air route over the "Burma hump" carries cargo from railhead in Assam, India, to Yunnan, China.

4 Ledo Road, following invading Allied army, promises a highway link to Chinese-held portion of Burma Road.

SHADED AREA REPRESENTS FARTHEST JAPANESE PENETRATION ON ASIATIC MAINLAND

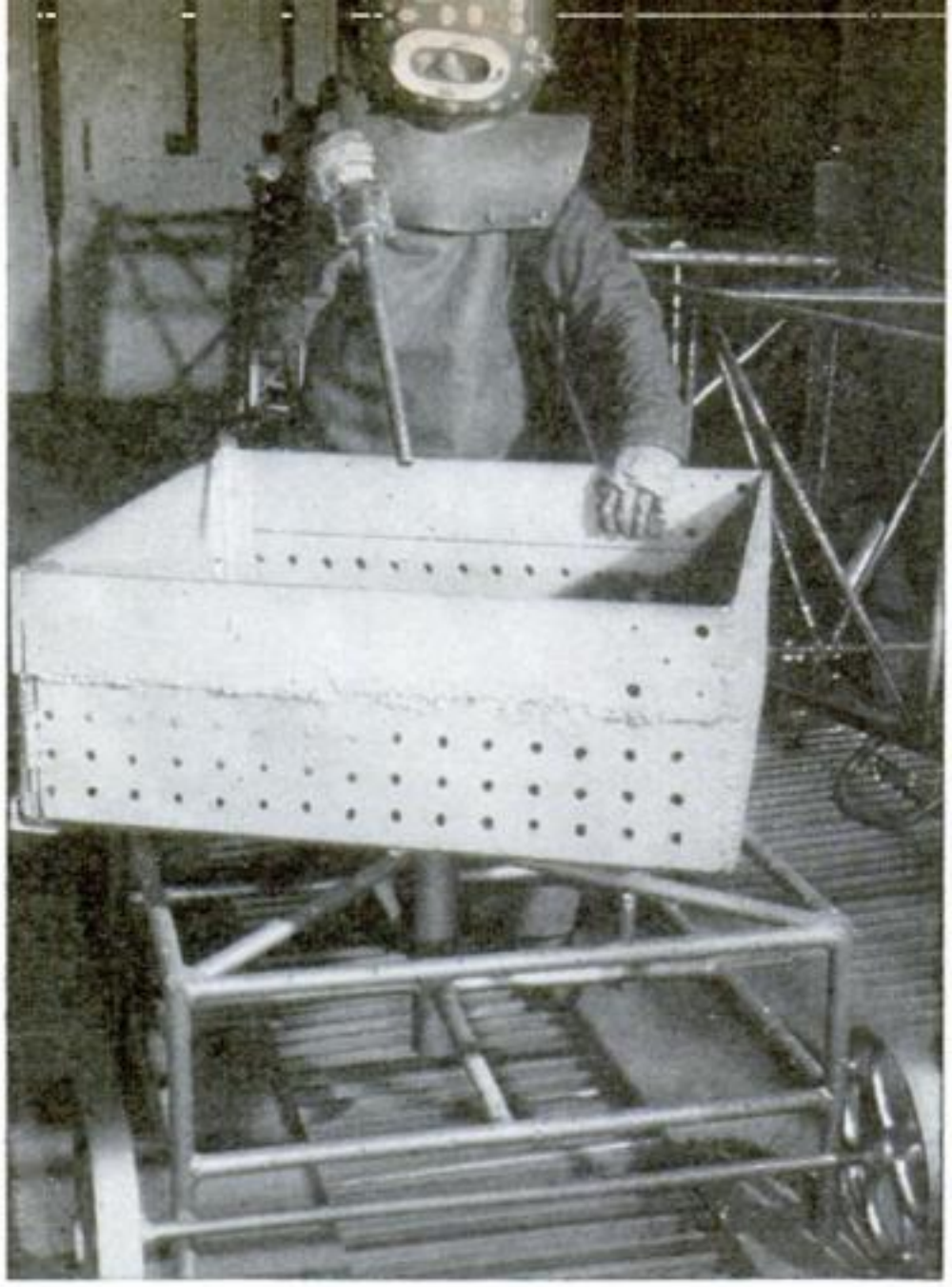




CARGO PLANES, flying the "Burma hump" across from India, now bring a greater flow of arms into China than the Burma Road trucks ever did. First ships to fly the perilous mountain route were old DC-3's. Today, sleek, four-engined Constellations and twin-engined C-46's are on the job. The Constellation (above) has a handy pressurized cabin

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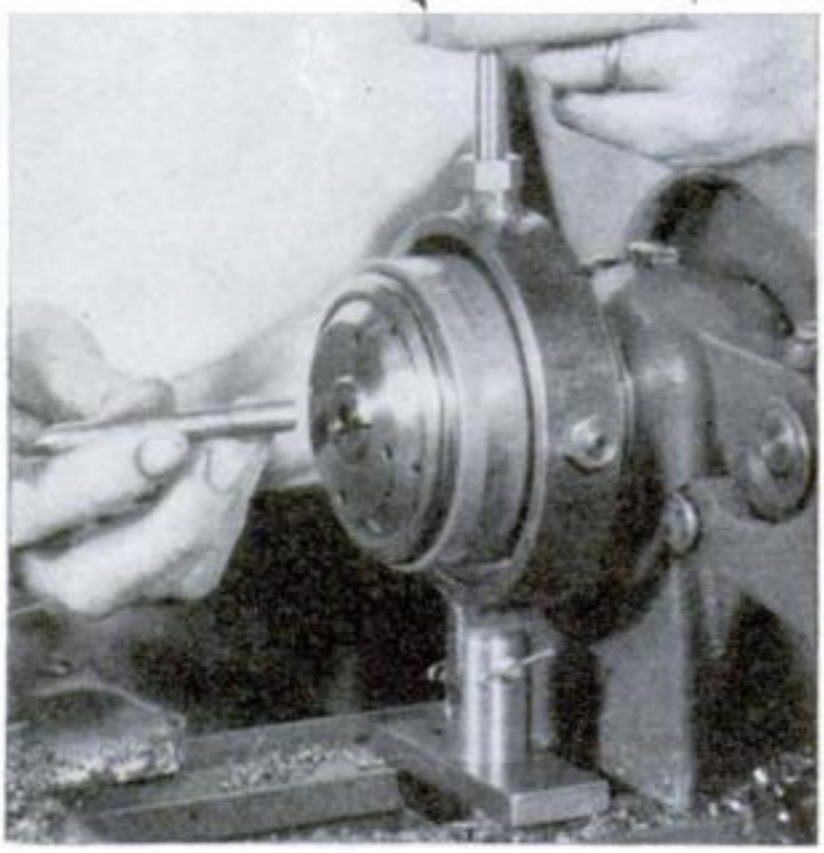
NEW Tools

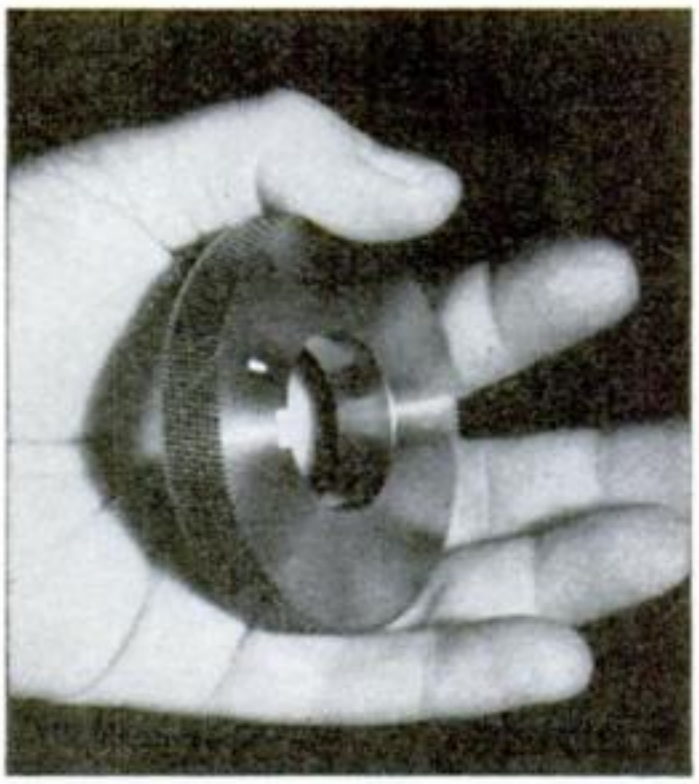


MASS SANDBLASTING in this homemade metal hopper saves countless man-hours formerly spent in handling small airplane parts individually. The idea won promotion for Harry Clinesmith, of Boeing Airplane Co., Wichita, Kans.

ONE FINGER opens or closes this compact, quick-acting collet chuck developed by Ray W. Goodwin and made by the J. & J. Machine Co., of Cuyahoga Falls, Ohio.

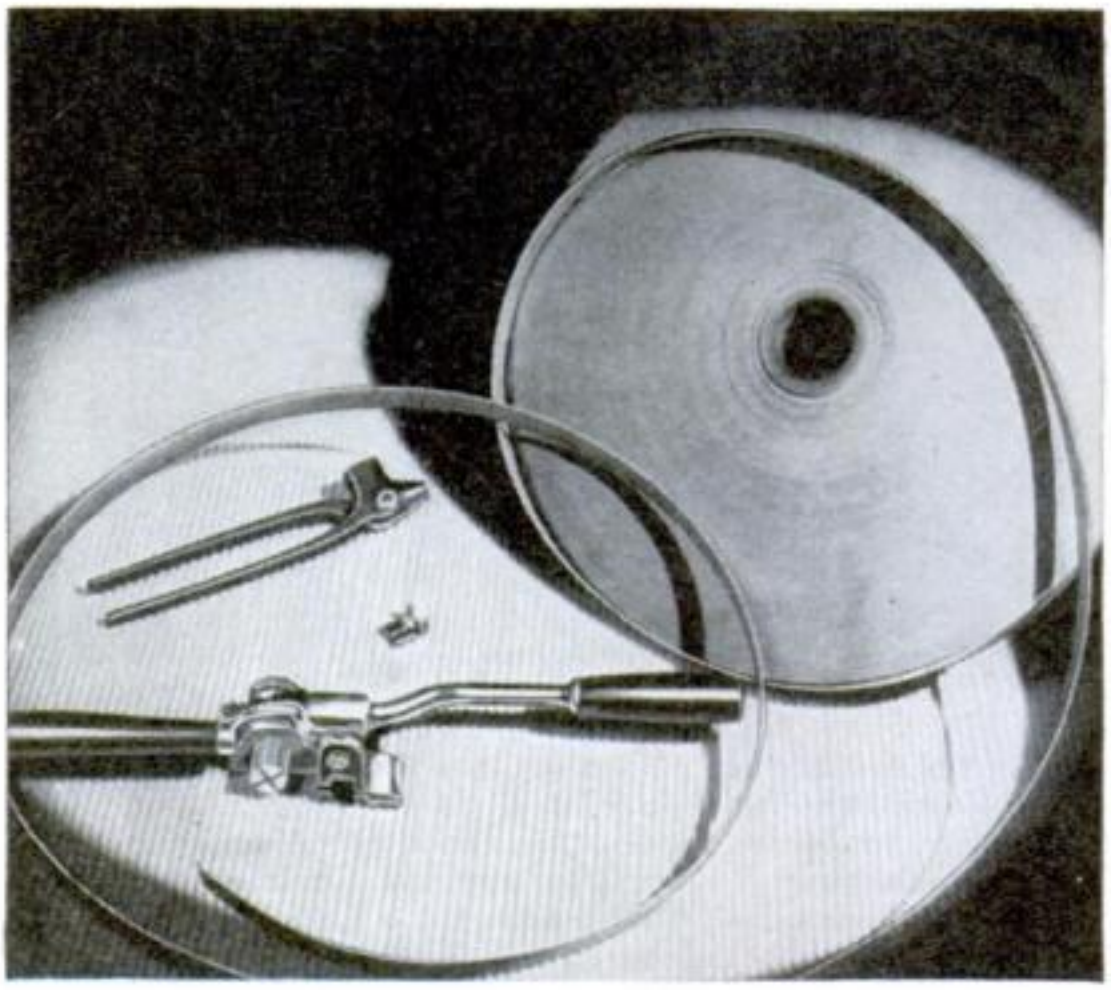






6,408 TEETH IN ONE TOOL. Each of the carefully ground edges in this gear cutter, made by the Michigan Tool Co., Detroit, is a separate tool, which removes its own chip in the process of finishing precision gears by the crossed-axis gear-shaving principle.

STRAPPING of laminated fiber replaces steel strap as reinforcement in packaging for domestic shipments. The easily applied material was created by A. J. Gerrard & Co., of Chicago.



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CAN WE LAND OUR PLANES SAFELY?

As our war birds gain in speed and weight, the gear that gets them off the ground has to take a terrific beating.

By C. B. COLBY

Drawings by DOUGLAS ROLFE

NOT long ago, a mammoth new experimental bomber was trundled out of its concrete-floored hangar onto the macadam apron in front of the building—and promptly sank into the surface up to its hubs! The weight carried by its giant wheels was too much for paving designed to support the heaviest aircraft previously built. After the plane was fished out, those wheels not only carried it safely to a take-off, but even were fully retracted in flight!

A Flying Fortress smashes down upon a runway in an emergency landing, not with its normal dead weight of 30 tons, but with 60, 80, or even 90 tons of impact weight. The landing gear takes it, and can take it again and again if need be.

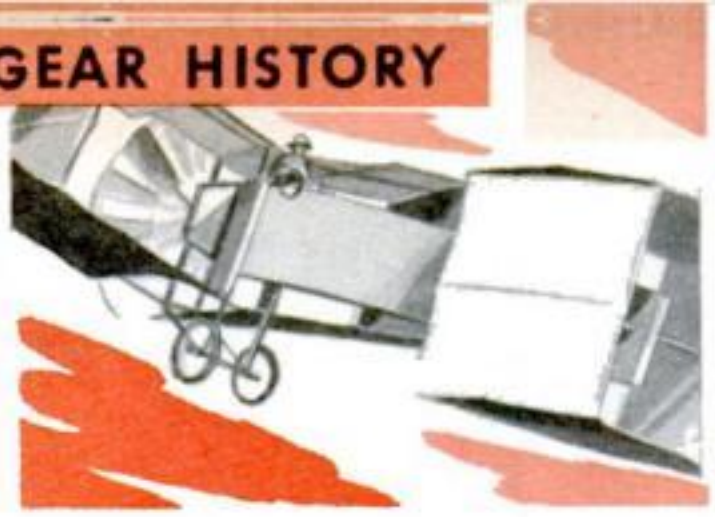
Fighter pilots get the word of enemy aircraft approaching and rush to their planes waiting with the engines roaring. They hurtle down the runway and take the air. The landing gear retracts into the fuselage and wings and becomes invisible—in 20 seconds! Upon their return, this same gear drops and becomes locked in landing position in 15 seconds. Moreover, the pilot knows at a glance at his instrument board exactly what posi-

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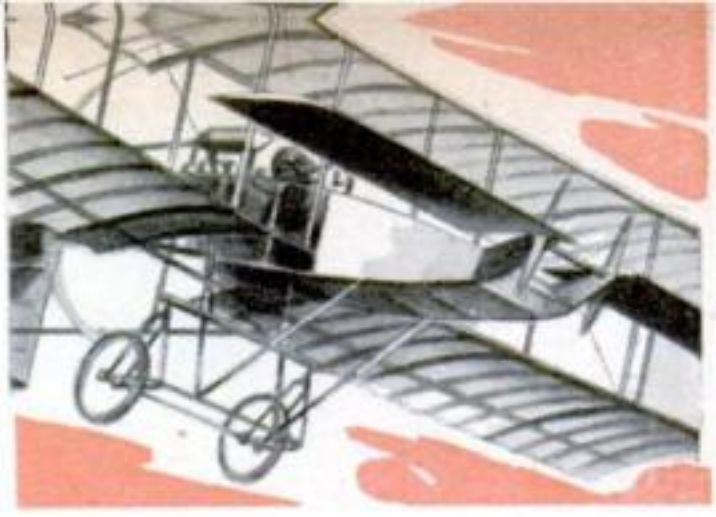
LANDING-GEAR HISTORY



1890 Skids resembling sled runners, fastened to the bottom of the fuselage of the original Ader "Eole," were the first mechanical landing gear. The plane flew but proved unmanageable in the air



1906 Wheels had been tried on experimental craft even before the Wrights' skid-equipped plane flew. One of the early practical applications was on the canard biplane, first plane to maintain free flight in the Old World



1907 Spring shock struts came in about the time of the Voisin biplane used by Farman. This was only one of many radical innovations to come out of France, the birthplace of wheeled landing gear

tion his landing gear is in at all times.

These are examples of the accomplishments of the engineers and designers of landing gear for our modern aircraft; accomplishments in the face of the most rigid space and weight limitations, for once the plane is airborne, landing gear becomes a liability rather than an asset.

There has always seemed to be a good-natured battle between the aircraft and landing-gear designers--to see which could gyp the other out of more space, but somehow or other they always get together in the end. Neither can succeed without the help of the other.

The problem confronting the gear designers varies with the ship itself, its mission, its speed, and pilot who will fly it. Training ships require sturdy gear and wide tracks (space between the wheels) for the ragged landings of students. Bombers need plenty of track, too, coupled with extreme weight-sustaining qualities and equipment to retract the heavy gear. Fighter planes must be equipped with gear that can be retracted and locked in 20 seconds and lowered and locked in 15 seconds, brakes for short stops on small fields, and rugged tires that can stand high-speed landings on rough fields. As the weight and speed of modern aircraft increase, the designers of landing gear must provide safe, reliable, and compact landing gear to keep pace with them.

Tire engineers must, in turn, keep up with the gear designs and provide tires to withstand the tremendous loads, impacts, and burns encountered in hundreds of landings on the worst possible runways. Tires can be made only so big, for there is limited room within the ships to accommodate them. To see just what this means in really big ships, consider the B-19, the Army's huge experimental bomber, with a span of 212 feet and a weight of 60 tons loaded. The single tires of this giant are eight feet in diameter and weigh over a ton apiece, with the wheel. Yet failure to retract them entirely would cut several hundreds of miles off the range of the monster plane, which is 7,750 miles.

Speed, too, must be considered in these giants, but in fighter planes the factor of speed is of even greater importance than strength in the design of retracting gear.

The Army Air Forces do not install retracting gear on aircraft having speeds less than 175 m.p.h., except in special types of trainers designed to acquaint students with its use. Above the 175-m.p.h. class it is almost mandatory, for its advantages far offset the added weight. (Equipping a plane with retracting gear calls for about 15 pounds of reinforcement for every pound of the gear and its retracting equipment.) With the present aircraft engines, speeds of over 300 m.p.h. would be next to impossible with fixed landing gear.

Naturally, these higher speeds mean that the landing speeds will be proportionately greater, and the gear must be designed to take the impact safely time and again on any surface. The fact that the surface of the landing area is not always of the best, and often far from it, has brought new popularity to an old idea—the tricycle landing gear. Such combat aircraft as the Bell P-39 and the Lockheed P-38, as well as the giant Consolidated B-24 and the Douglas C-54, use the tricycle gear. So do the medium bombers in the North American B-25 and Martin B-26 class.

The admitted safety of the tricycle gear, ease of ground handling, and better visibility indicate that this type of gear will soon be standard on private and commercial as well as military aircraft.

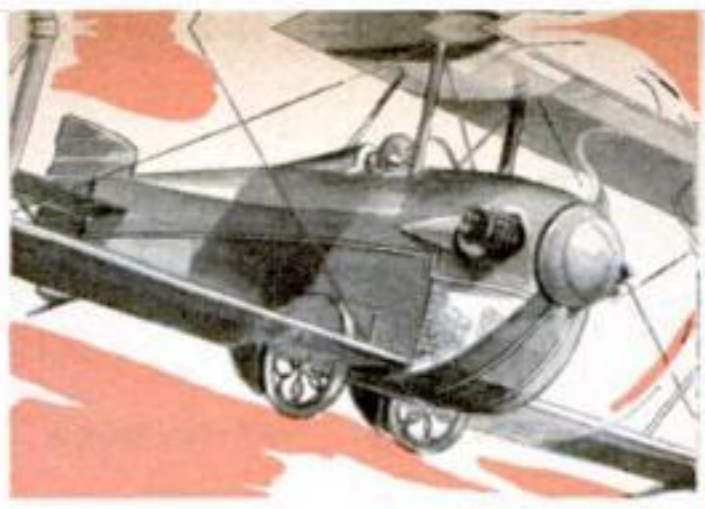
One of the greatest advantages of this gear is the ability of the craft to operate from much smaller fields. The pilot may safely apply his brakes almost as soon as he "touches down," and in the take-off he need not use up valuable runway in getting his tail up into flying position, for it already is elevated before the take-off run is started.

The inclusion of tricycle gear of either retracting or fixed type will undoubtedly be mandatory in future private planes, because

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1911 Antoinette wore pants. This, the last model designed by Labouchere, was remarkable for its enclosed undercarriage as well as for its internally stressed, tapered low wings; steam-cooled engine



1917 The principle of retractable landing gear was introduced by Capt. James V. Martin in his K-III Scout biplane, whose wheels could be partially withdrawn into wells. The wheel spokes—flat springs—absorbed shock

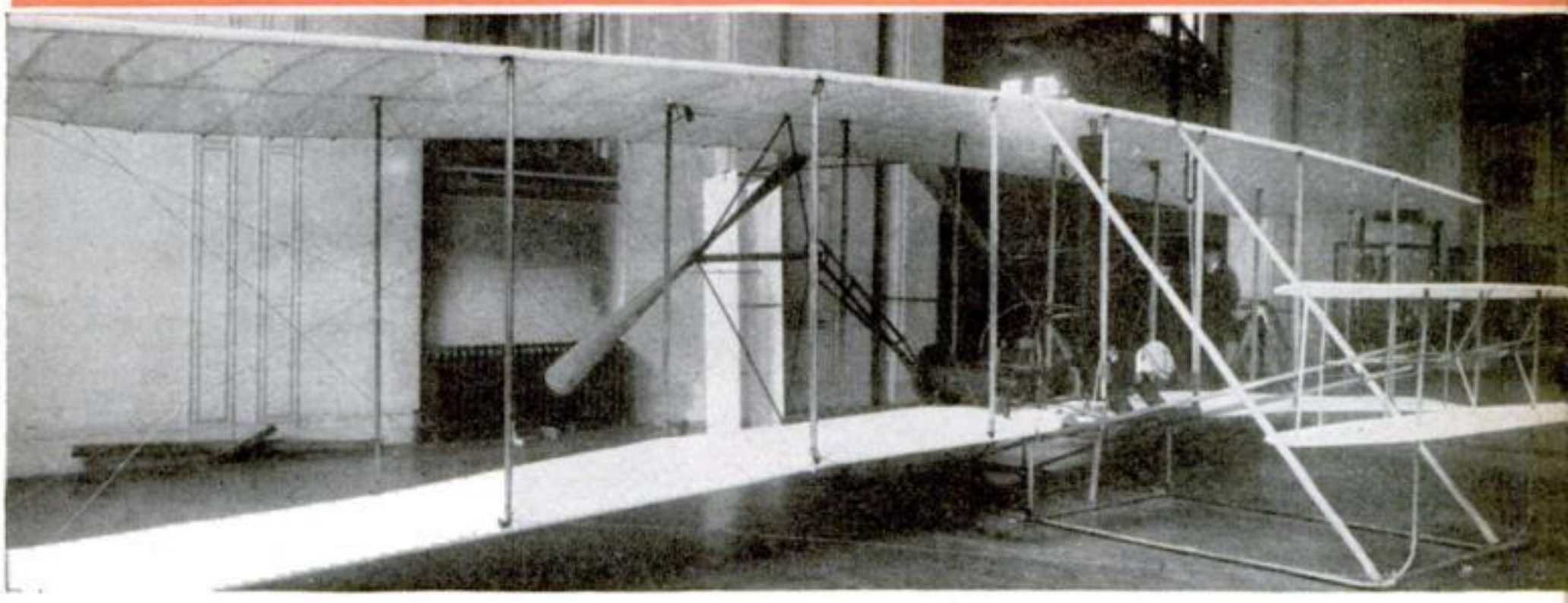


1918 Also attributed to Martin was the split-axle landing gear, here shown on a De Havilland of the period. The split axle removed much of the hazard from landings on rough, overgrown land

of its obvious safety advantages. At present, such ships as the Skyfarer and Ercoupe already feature it.

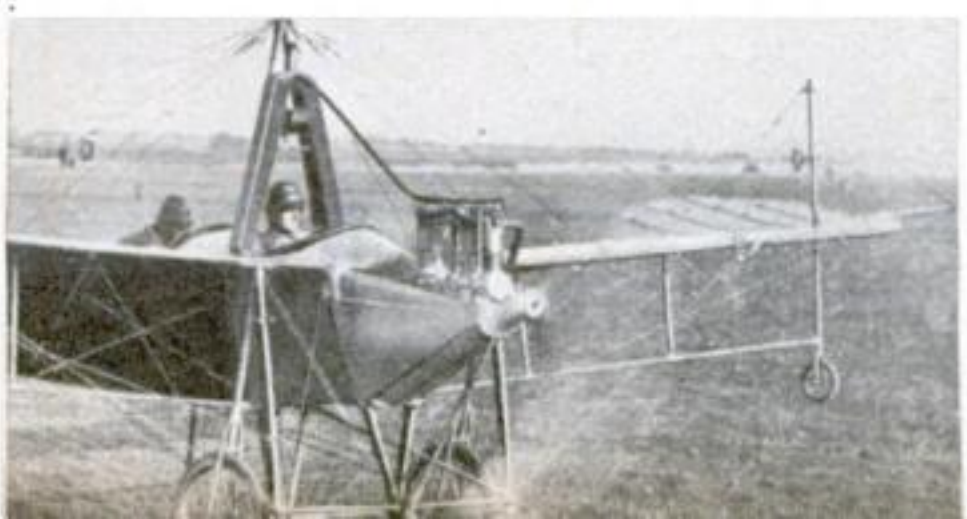
As we trace the history of landing gear from the time when Lilienthal used his running feet for glider take-off, we find many novel ideas in gear design. The first mechanical landing gear is claimed for the "Eole," built and said to have been flown in 1890 by Clement F. Ader, of France. This weird aircraft landed, though tragically, on three ski-like skids on the bottom of the fuselage, similar to those later used on the Wright airplane. *(Continued on page 80)*

SKIDS: THE SIMPLEST TYPE OF LANDING GEAR

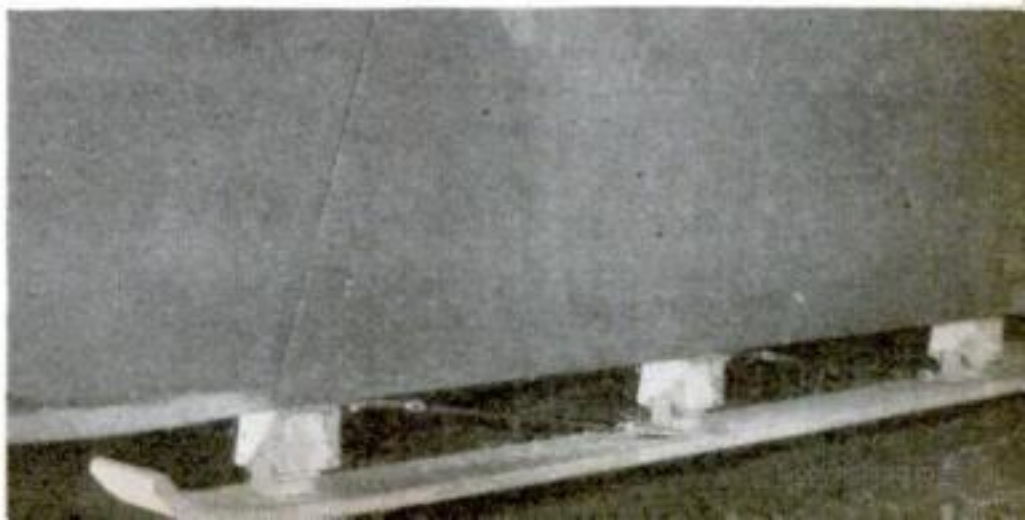


WRIGHT BROTHERS. The first powered plane to achieve sustained flight with a passenger had landing gear consisting of wooden skids turned up slightly in front. For the take-off, these rested on a wooden carriage that slid along a 60-foot, iron-covered monorail track laid on the slope of a sand dune. As the carriage slid down the greased rail, the plane took off when sufficient speed had been attained

NOSE GUARD. On this early monoplane, a nose skid ran from the center of the axle to a point just behind and below the prop. This was to prevent nose-over. Note wing-tip wheel for "Chinese landing" (wun wing low)



GLIDERS are among the few types of aircraft that still use skids. Below is one of the four skids on the Army's CG-4A troop and cargo glider. With shock absorbers, the skids are used in crash landings where wheels are out





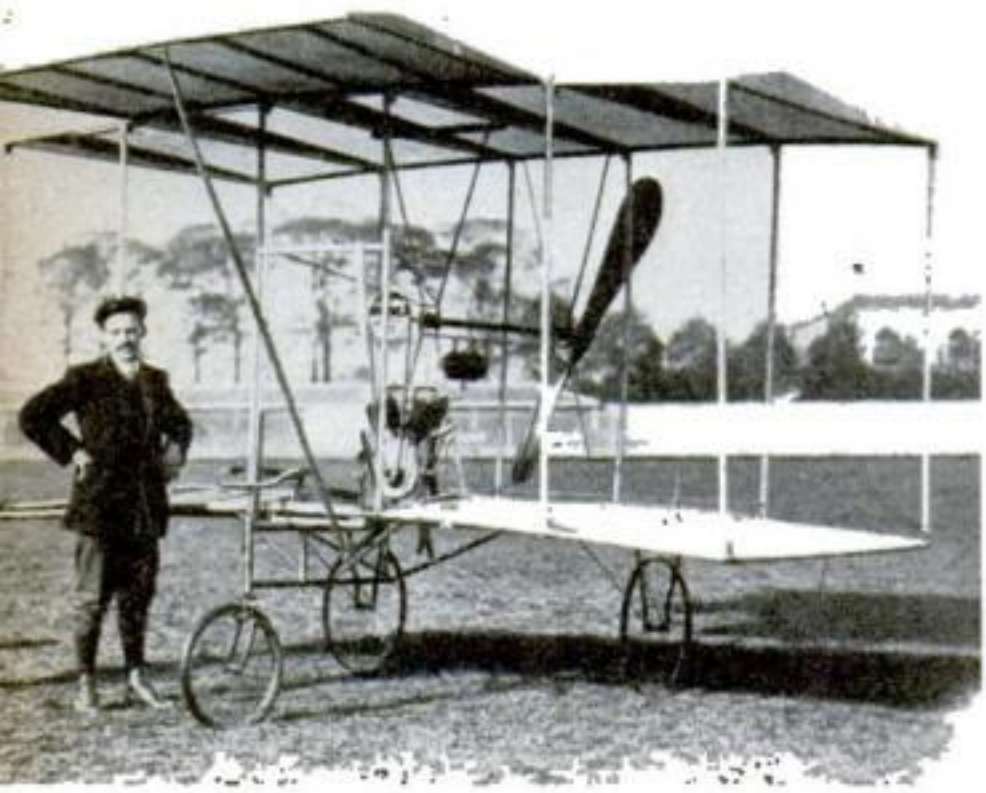
FIXED GEAR is used on training planes and private planes of slower types. On trainers such as this Fairchild PT-19, it gives a wide track and low center of gravity for safety



RETRACTING gear is standard on modern combat aircraft. In this Grumman Hellcat, the gear folds straight back into the wing, with the wheel and strut making a half turn as it does so. When retracted, gear lies flat in the underside of wing

PANTS reduce drag on big planes that have no room for retracting gear. The Handley Page Harrow at the right has streamline enclosures not only on the main landing-gear wheels but also on the tail wheel. In a slow plane, weight of pants is repaid in improved performance







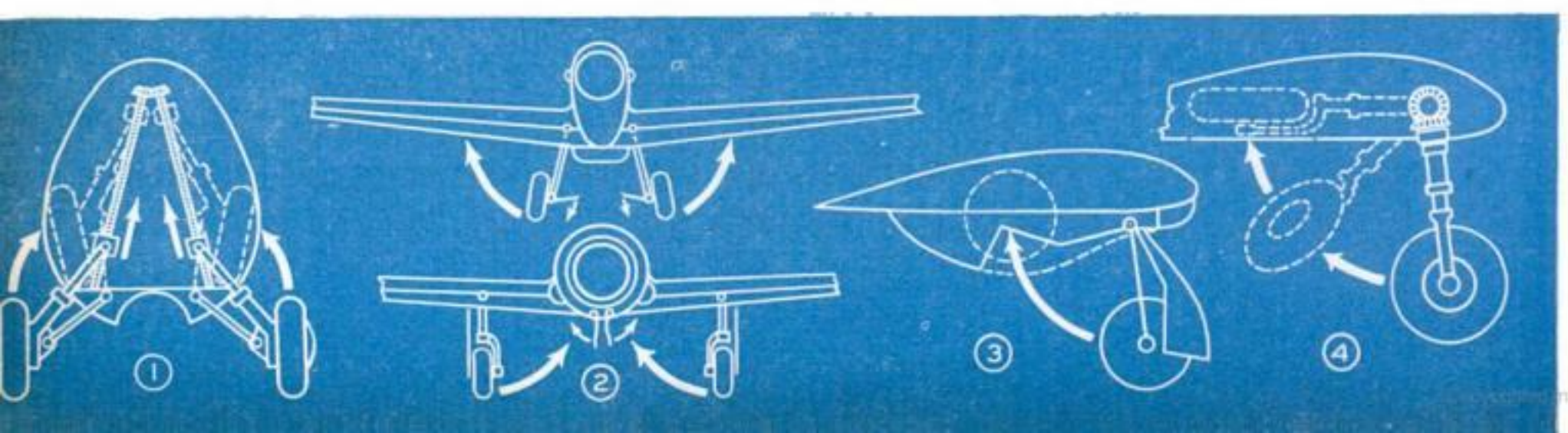
FIRST MILITARY plane to be delivered with retracting landing gear was this Grumman FF-1. Gear was drawn up into the fuselage so that the wheels fitted into the round wells. Bad feature was narrow track; compare with fixed-gear trainer at top left

EARLY TRICYCLE gear appeared on the Edward Mines biplane (left) in 1909. Obviously made from bicycle parts, it still has the handlebar attached, with the hand grip for the wheel brake in evidence

RETRACTING GEAR HIDE IN MANY WAYS AND

1. On the Grumman Wildcat, the wheels are drawn up and inward on hinges moved by a system of revolving threaded rods and nuts. As the rods revolve, the nuts climb, drawing the gear up into the fuselage. 2. British Spitfires and German ME-109's swing gear outward; P-39 Airacobra and Hawker Hurricane swing them inward

3. Retracting gear of Seversky P-35 folds backward but does not lie flat against underside of wing. Wheel and gear are covered with a hood. 4. On the Curtiss P-40 series and Grumman Hellcat, gear rotates and folds backward at the same time, so that the gear lies within the bottom of the wing when it is fully retracted



NOW STANDARD GEAR FOR ALL LAND PLANES



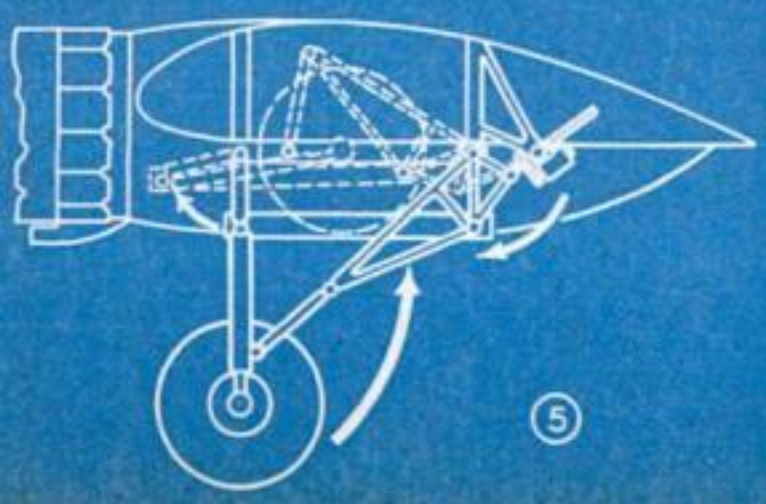
TRICYCLE GEAR is seen in a modern version on the Consolidated B-24 Liberator. This gear is unusual in that the nose wheel, when extended, still has its top within the fuselage. The two main wheels retract outward, an uncommon feature in big ships although standard practice in fighter planes. In contrast with the short nose gear of this plane, that of the Constellation extends nearly 15 feet

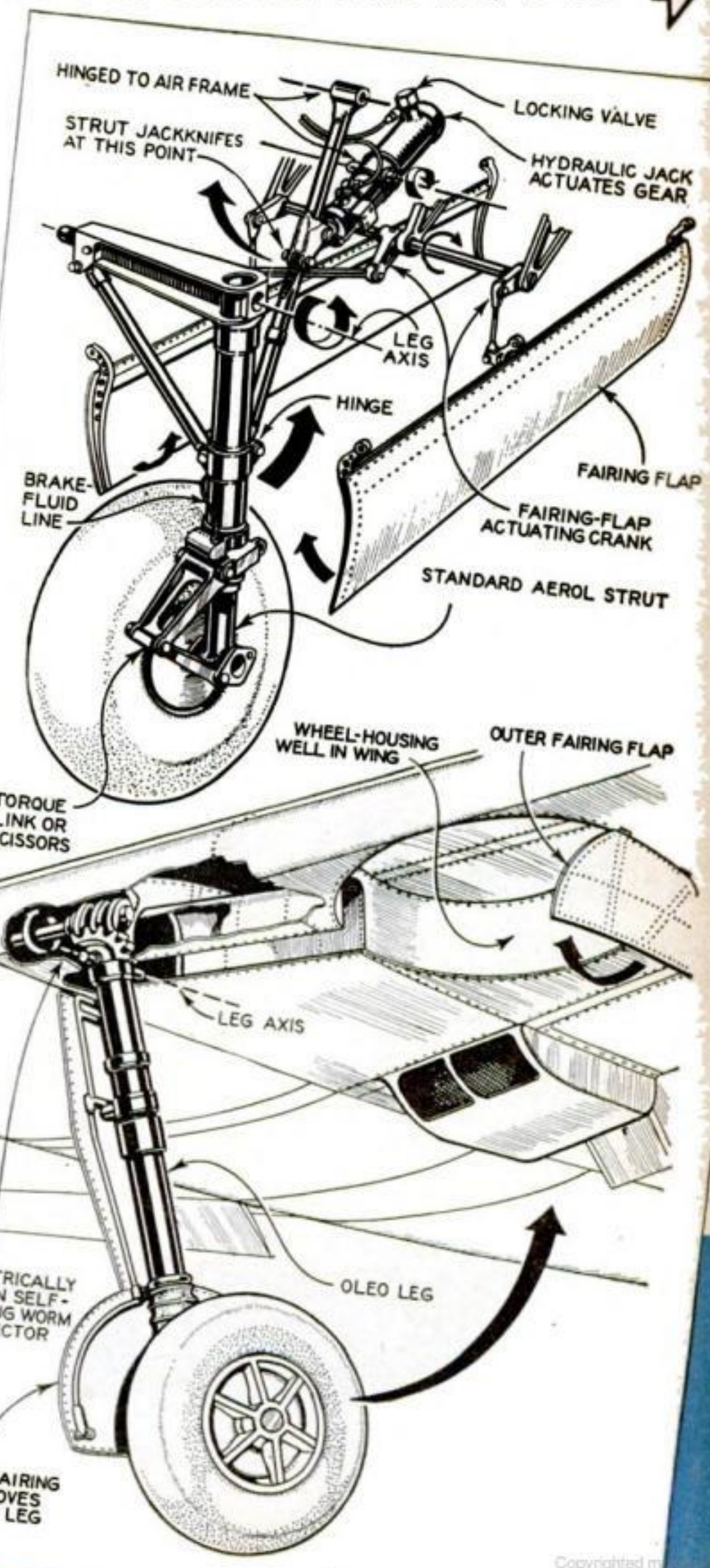


AMPHIBIOUS. This is the retracting gear of a Catalina PBY amphibian. When the ship is used on water, gear rises to fill opening in hull. Metal "step" is a hinged flap that closes the slotlike opening above the wheel. The double-wheel unit is the beaching gear

IN MANY PLACES

5. This is the type of gear used on the familiar DC-3 transport and on the Boeing Flying Fortress. It buckles in the middle and folds back upon itself as it retracts into the engine nacelle. Drawings at right show mechanics of two retracting-gear types





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SPECIAL TYPES OF GEAR FOR SPECIAL JOBS



SEAPLANES use floats. This Curtiss Seagull has triple-float gear, the center float being the main landing gear while the wing-tip floats help in rough water. Most Navy "slingshot" planes of this size use the single-float gear



HELICOPTERS may use either wheels or floats. Rubber floats on this Sikorsky model enable it to land on water or on shipboard. For land operation, wheels are commonly used, not for take-offs but for easy handling on the ground

Strangely enough, wheels—now accepted as standard landing gear for all but seaplanes—were employed on an experimental aircraft long before the skid-equipped Wright plane actually flew.

In 1893, Horatio Phillips, an Englishman, built a tethered aircraft that rested on a tricycle gear. This machine ran around a circular track and at 40 miles an hour took off and circled the track several times.

Wheels, of course, rapidly became standard equipment and appeared in various sizes and types. At first they were rigidly attached to the struts, but the impact of landings broke rims, spokes, tires, and struts, indicating that some sort of shock-absorbing device was needed. One of the first aircraft to employ steel springs was the French Voisin, made famous by Henri Farman. France, where wheel-equipped landing gear originated, produced many startling types of gear. One featured tandem wheels on the fuselage and a wheel attached to each wing tip.

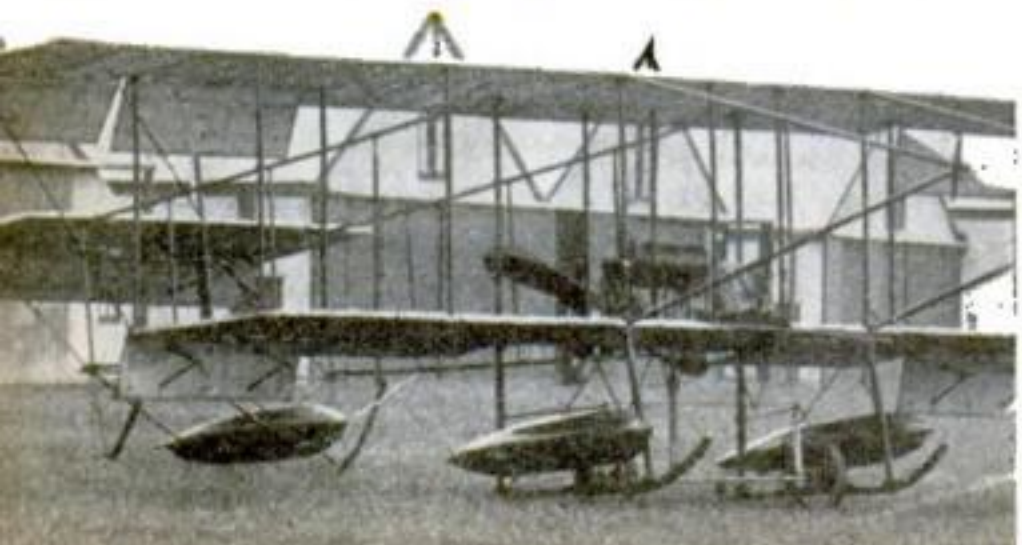
Enclosed wheels, common during World War I, appeared in 1908. Records show that a small triplane, built by the Danish flyer Ellenhammer and powered with one of the first tractor propellers, featured a tail wheel closed in with fabric. This evidently was intended to serve as added fin area for stability—which most pioneer aircraft sadly lacked.

World War I saw general acceptance of the enclosed wheel, elastic shock cords, and also the strut-and-spreader-bar design. The closed-in wheels increased the speed slightly, the elastic cord was adequate for shock absorbing, and the spreader bar added strength.

As speed became more important, the drag of rigid landing struts presented a difficult problem. Anthony Fokker made an important contribution in his famous Fokker D-7 and subsequent models by designing the spreader bar as a high-lift airfoil section between the wheels.

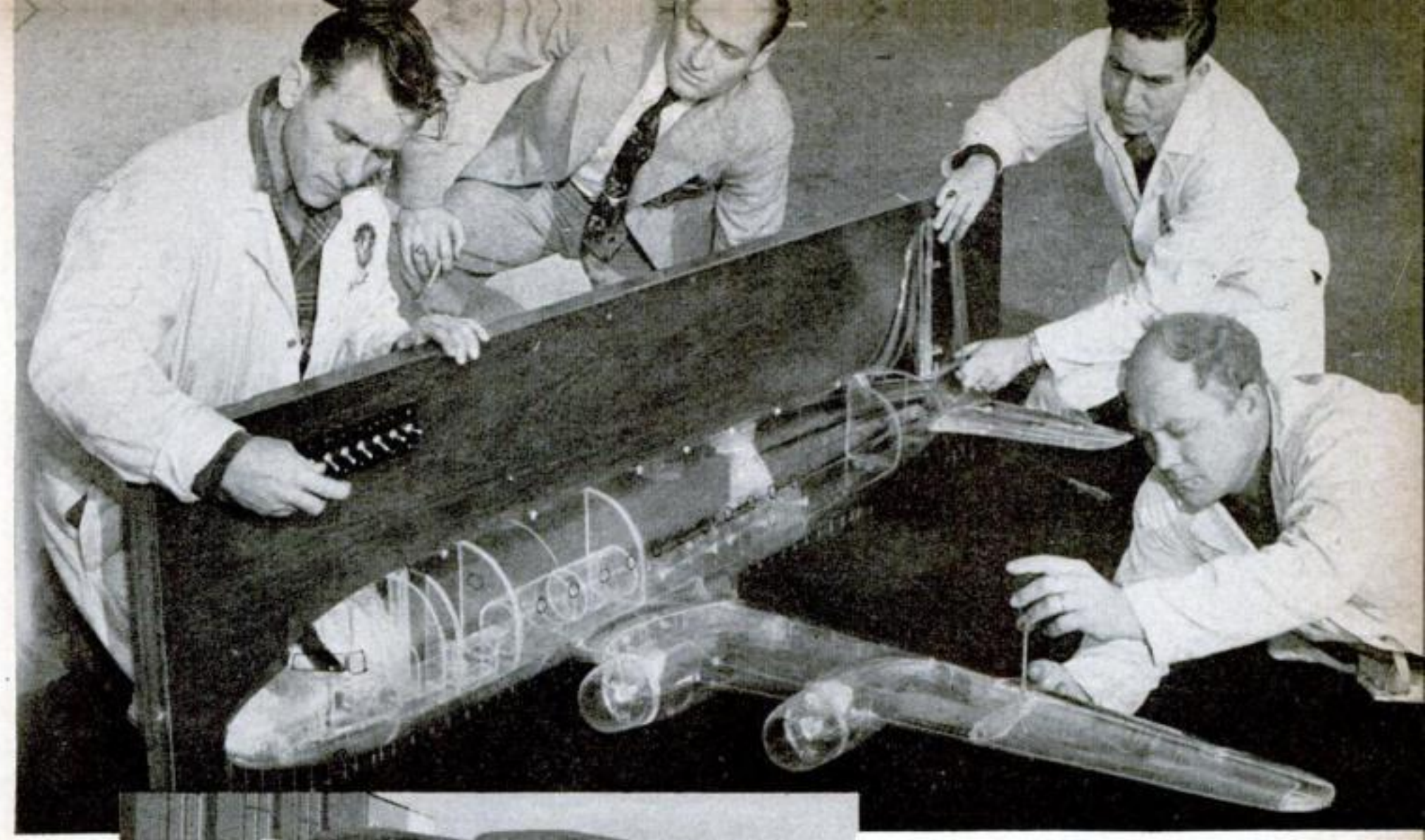
Various types of streamlined housing for the gear were designed as early as 1912. The Antoinette monoplane that featured "trousers" also boasted another innovation in a tapered cantilever wing. Early landing-gear "pants," while they increased the speed of the planes, had *(Continued on page 203)*

ALL-PURPOSE operation seemed to be the idea of the designer of this early plane—or else he just couldn't make up his mind. It had everything: wheels, pontons, and skids



SKIS fit this land plane for landing on snow or ice. Elastic cords hold the ski tips up in flight so they will not trip up the plane in a landing





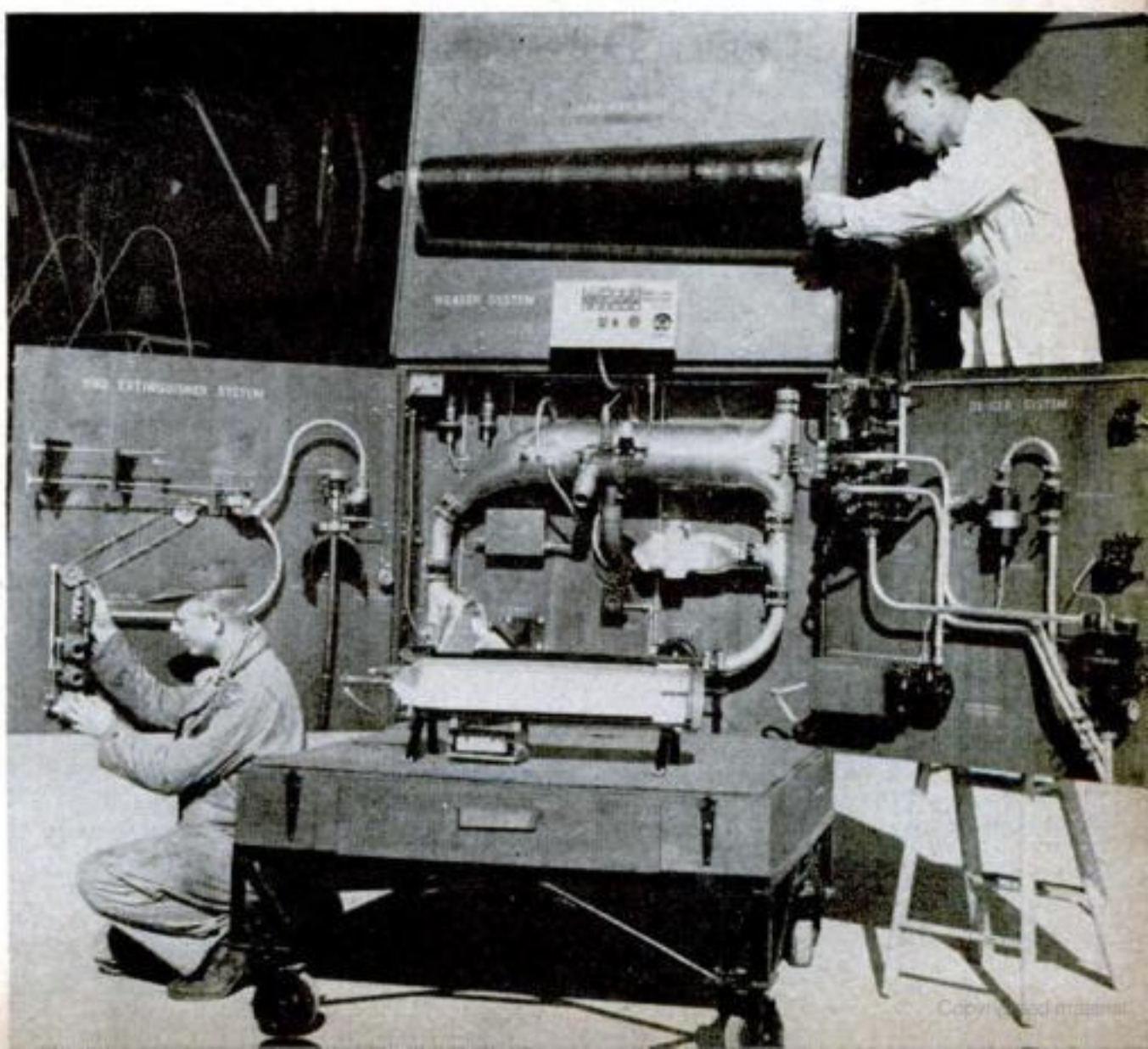


To teach Army mechanics methods of servicing the plane that carries many critical materials to the front lines, this Plexiglas half-model of the four-engine C-54 Douglas transport is included among the items of the mobile training unit. At left, exhibits are being loaded onto truck

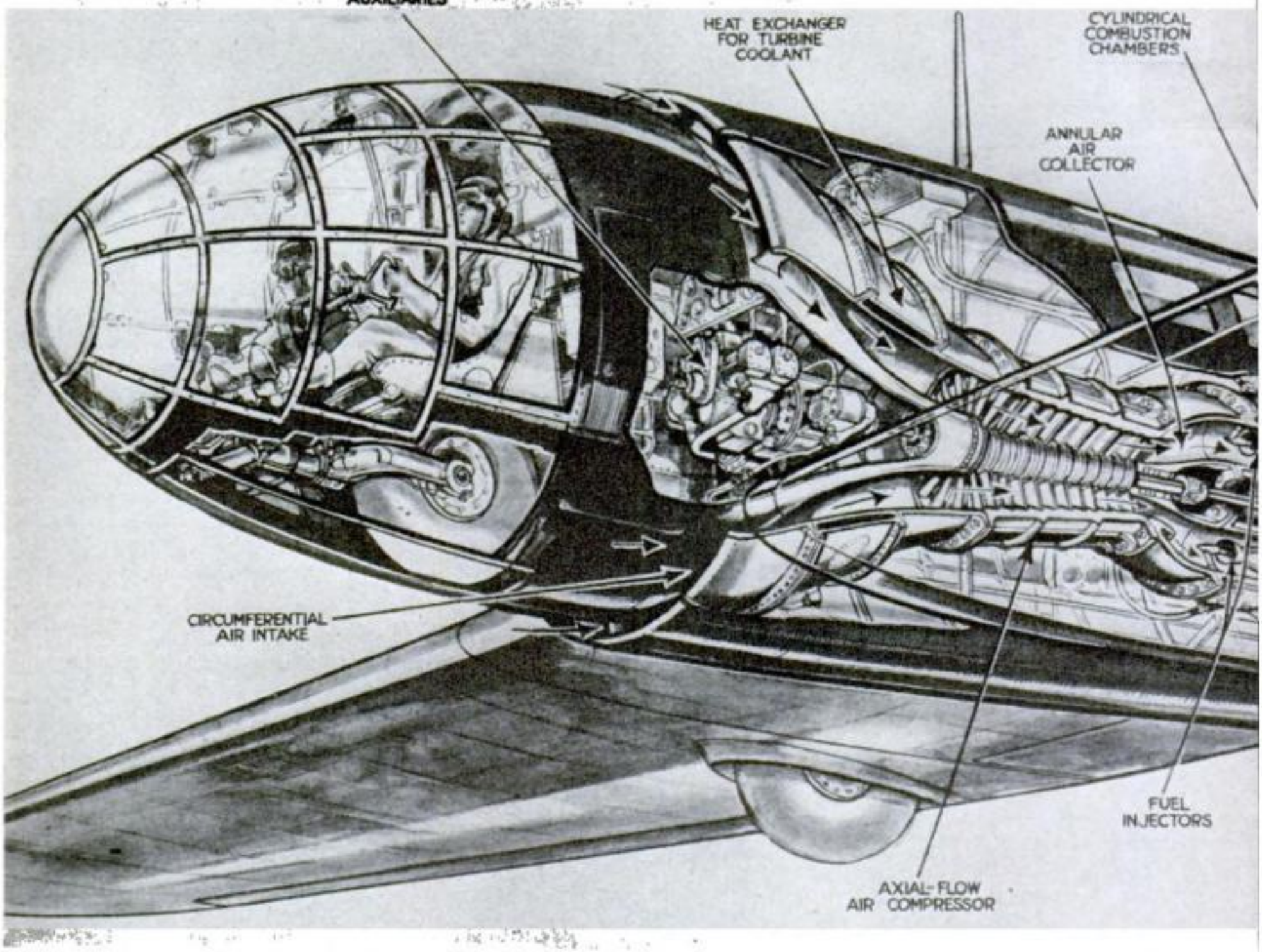
"Road Show" Trains Skymaster Crews

CONTAINING in miniature all the functional systems of the four-engine Douglas C-54 Skymaster, large plane used for transport of supplies to military outposts, an exhibit of models, parts, and working mechanisms enables flight and ground crews to "learn their planes" during a brief course. Eight boxes, moved from one Air Transport Command field to another in a specially fitted truck, contain models showing the muscles, nerves, brain, heart, and arteries of the C-54. From these, the men learn how to assemble, install, and service the systems. In a Plexiglas half-model working parts are controlled by switches and cables.

Fire-extinguishing, heating, and de-icing systems are combined in this four-panel display. In miniature, it contains all the many elements employed in the C-54. Casters on the exhibits facilitate moving them when they are packed



HOW WILL JET PROPULSION AFFECT AIRCRAFT DESIGN? HERE IS A BRITISH ARTIST'S IDEA



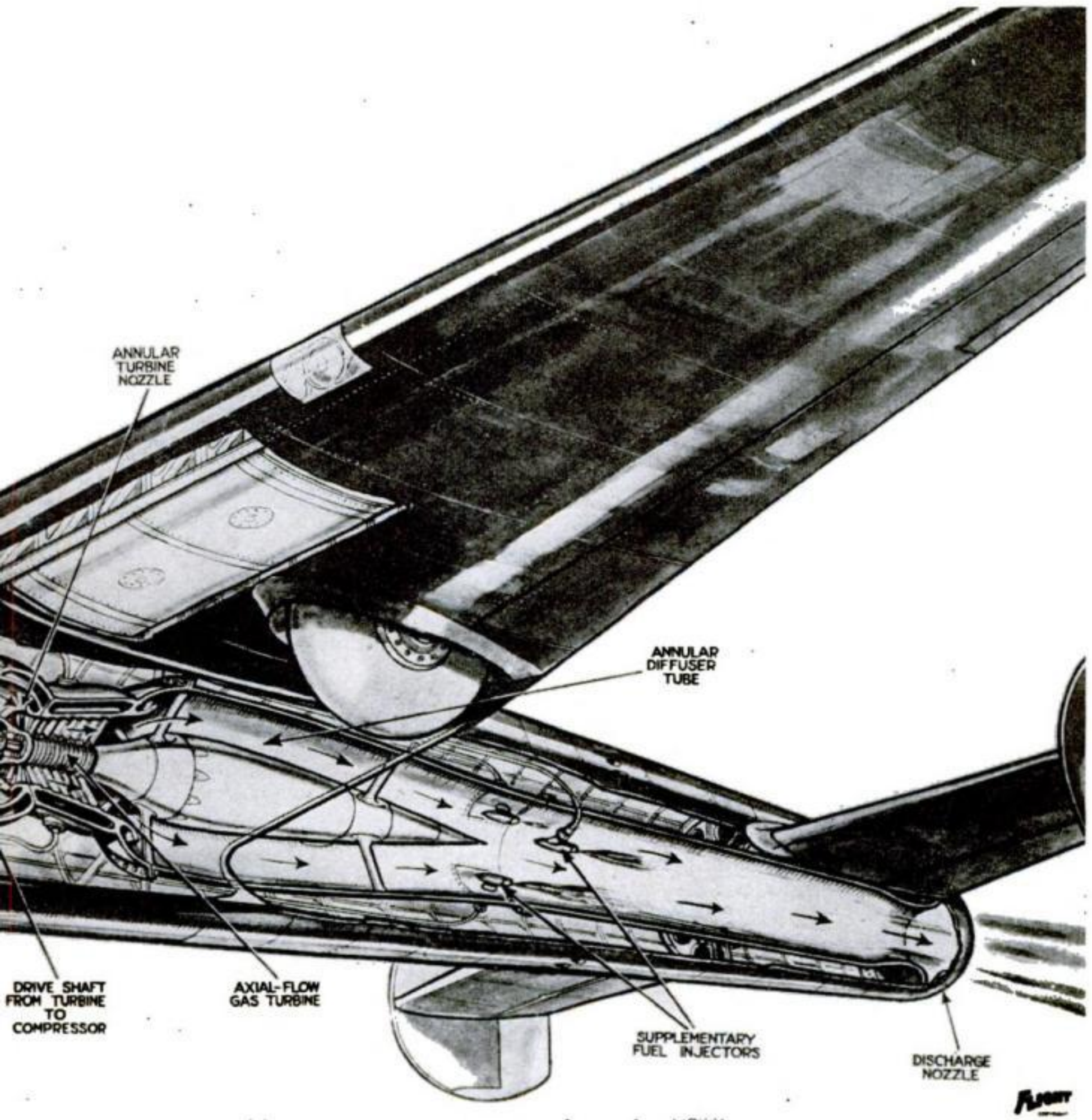
Propellerless Power for Planes

JET propulsion, thrown into the limelight by the simultaneous announcement of British and American warplanes using this new type of power plant (P.S.M., April '44, p. 85), has been hailed in some quarters as one of the greatest advances in the history of aviation. Certainly it promises new speed and power for aircraft in certain categories.

Apart from the advantages or disadvantages of the jet engine as a source of power, some interesting questions are raised by its application to the conventional features of aircraft design. How will it adapt itself to the familiar lines of propeller-driven planes? Builders will be confronted with an entirely new set of conditions in the apportionment of space and the planning of auxiliary equipment to make an efficient fighting or working ship.

A tentative answer to some of these problems is seen in the drawing above. Made by M. A. Miller for the magazine *Flight*, it gives the British artist's conception of an

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Presents New Problems to Builders

idealized jet-propelled plane combining various features common to this type of craft.

A notable change is the low landing gear, with main wheels partly submerged and nose wheel retracted. Having no propeller, the jet plane is freed from the limitation imposed on conventional planes, which must stand high enough on the ground that their blade tips will clear by at least nine inches under all conditions. In warplanes, the absence of the propeller and engine cowling also permits better visibility from the cockpit and greater freedom in the mounting of forward guns.

In this conception, a single jet engine occupies the main fuselage of the plane, air being picked up from around the nose by a circumferential scoop. According to press reports, the actual British jet plane has two engines mounted in twin fuselages and has been mistaken for the American P-38. An auxiliary engine is used in starting, to turn the air compressor. In operation, this is done by the turbine.

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He Gave the



Four .50 caliber machine guns spitting from the Maxson multiple mount give American troops and truck convoys a sturdy champion against low-flying Axis strafers. Carried by a half-track "wasp wagon," it is, in effect, a mobile pillbox. Designer of the mount is William L. Maxson, shown at upper left with the jeweler's lathe which was his only piece of equipment when he set up in business as an inventor nine years ago

Drawings by STEWART ROUSE

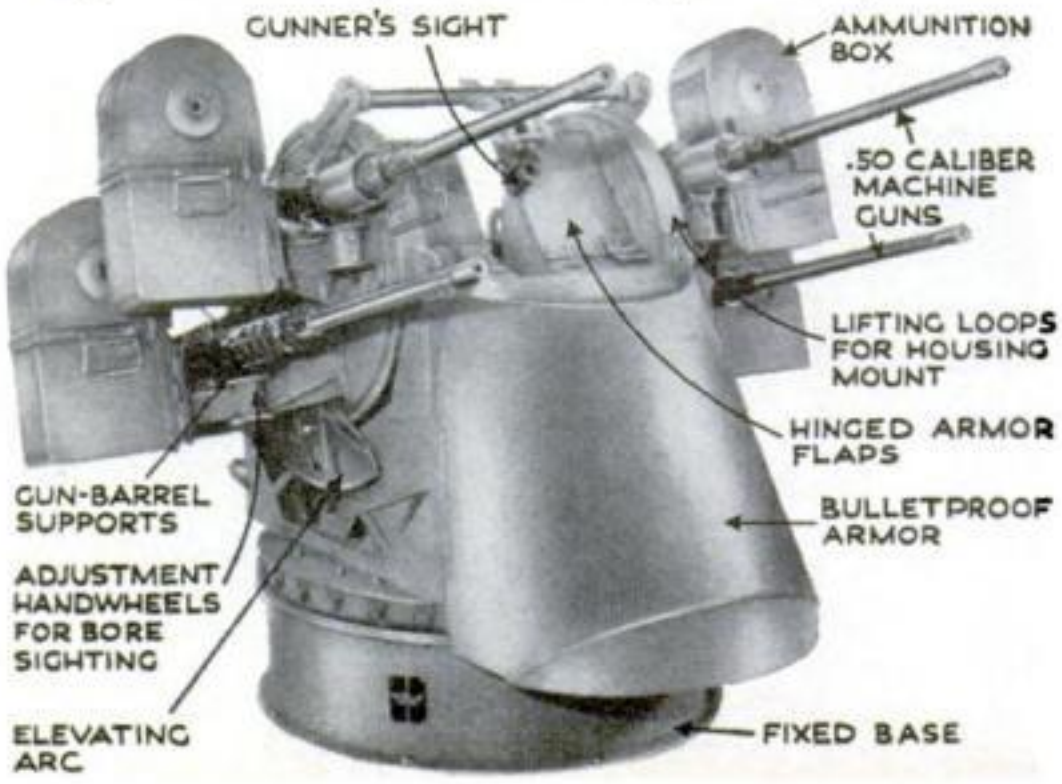
By VOLTA TORREY

GIVE a soldier four machine guns, each weighing 87 pounds. Wrap him in armor and set him on wheels. Then ask him to hit a darting, diving Nazi warplane. It can be done. He can squirt thousands of bullets a minute at that tricky target as steadily and easily as a small boy can point a wooden gun and say uh-uh-uh-uh.

William L. Maxson, a former midshipman from Minnesota, made this possible by designing for the U. S. Army a new gun mount that holds four .50 caliber machine guns. With this multiple gun mount, the strength of a man's wrists is so multiplied that he can wield those four powerful, sputtering guns as though they were a couple of pistols. In fact, the handles with which he controls them resemble pistol handles.

Armored and mounted on a half-track truck or trailer, the Maxson multiple gun mount is a mobile pillbox. It has enabled our antiaircraft gunners to escort moving troops and protect them from enemy aircraft the way two-gun sheriffs used to protect stagecoaches from highwaymen.

Outstanding feature of Maxson's masterpiece is the ease with which one man can aim and fire the heavy guns like a boy with a wooden pistol. Gunner is protected by armor



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Wasp Wagon Its Sting

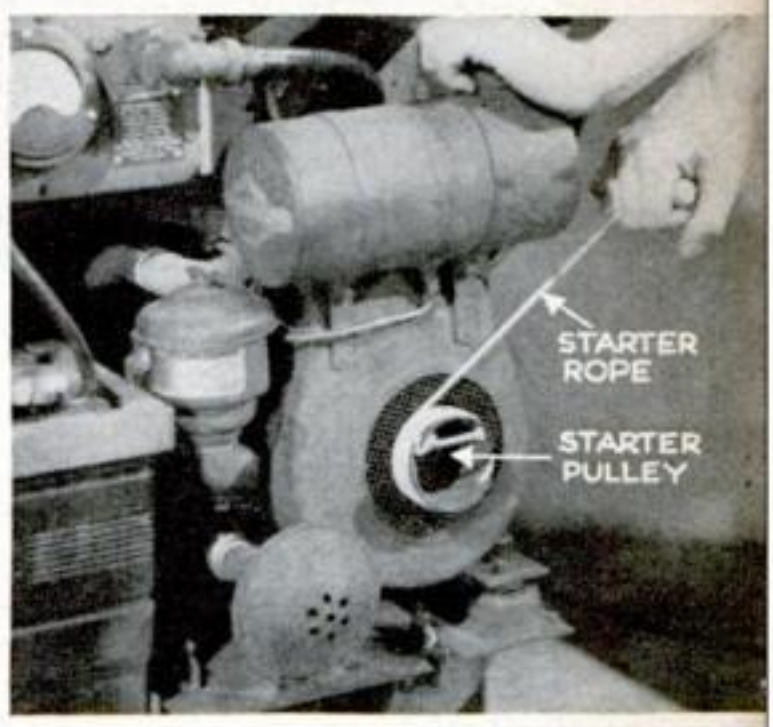
Maxson saw the need for such a gun mount late in 1941, while sitting on a log and chatting with some Army officers at Aberdeen Proving Ground. They were watching antiaircraft men experiment with an aircraft turret. It didn't work very well.

To land a fatal uppercut during a clinch with a fast, low plane, a man on the ground obviously needed a heavy gun. He also needed a support that would permit him to direct its fire without exerting himself physically. Otherwise he could not concentrate on aiming. And even the best marksman would miss if the machinery for shifting his gun jerked it, or responded too slowly or too quickly to his touch. Obviously, too, this machinery should be portable, and its operator should be as well protected as possible from the attacking plane's fire.

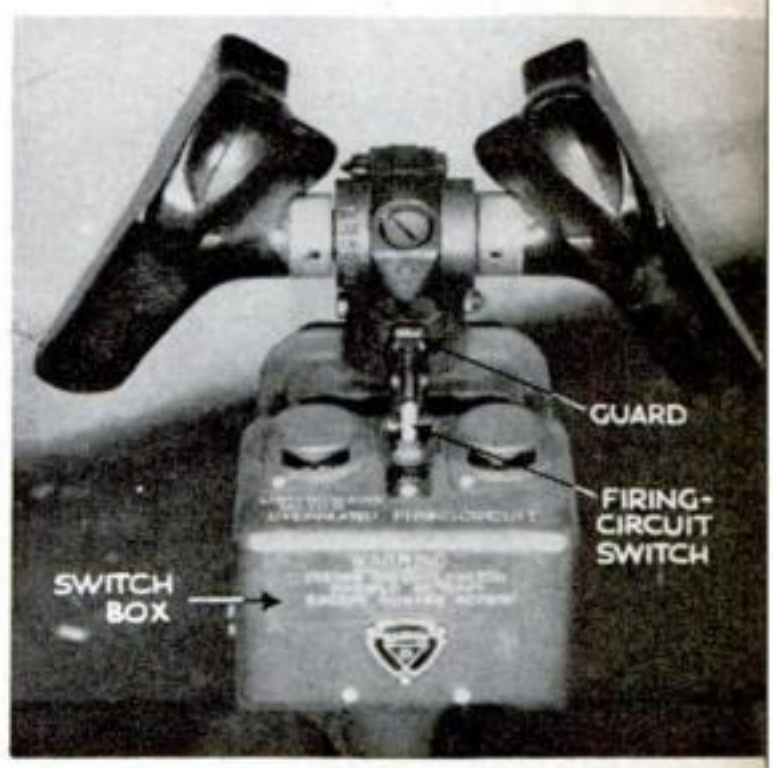
As a specialist in naval gunnery, Maxson was intrigued by this Army problem. After the last war he had done three years' postgraduate work at Annapolis and remained in the uniform of a lieutenant until 1935. Then, with only $200 capital and only one piece of equipment, a jeweler's lathe, he had gone into business for himself in New York. One of his first and most important inventions was a calculating machine to give navigators their position. Howard Hughes used it on his flight around the world. It worked and it was adopted by the Army. But before long someone else found a much cheaper way to get the same results, and Maxson's pet product was no longer needed.

Meanwhile, as a consulting engineer for the makers of Sperry gyroscopes and other intricate electrical and mechanical devices, "Tuba" Maxson recruited a staff of engineers, equipped an experimental laboratory, and enlarged his plant. Much of his concern's work was on fire-control apparatus.

Consequently, when the Army ordered a pilot model of a multiple machine-gun mount from him, four days after Pearl Harbor, the Maxson organization was rarin' to go. The pilot model was produced in less than 60 days, even though some of its parts had to be invented. Taking the bugs out took a little longer. Then Uncle Sam reckoned he could use about $100,000,000 worth of

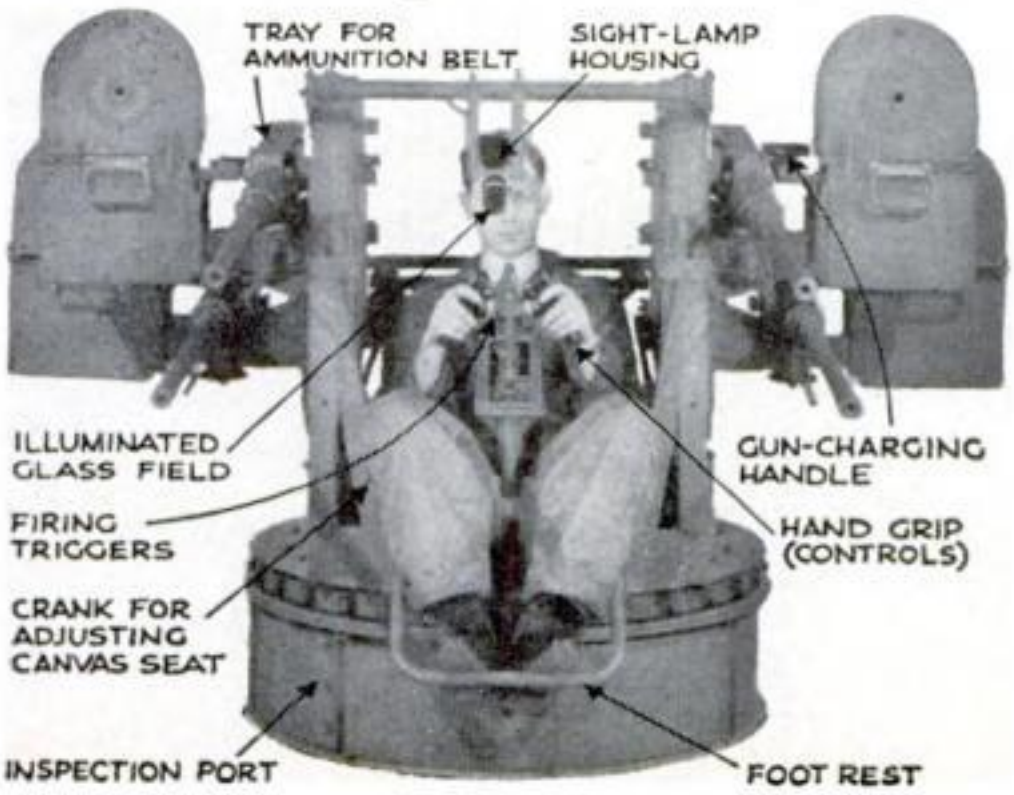


A tiny gasoline engine drives a generator to charge storage batteries. These supply power to a motor that moves guns



Turning these handles swings guns from side to side; tilting raises and lowers guns. To fire, the handles are squeezed

From a canvas seat that swings like a swivel chair, the gunner sights with one eye and watches his tracer bullets with the other. Sight moves with trunnions or guns



Nazi counterpart of the Maxson mount is this 20-mm. "Flakvierling" on the railway armored car that Hitler gave Il Duce, now used by U. S. troops



Maxson mounts. The first model carried only two guns. But a four-gun mount was soon perfected and thousands of them have been produced.

The half-tracks that carry Maxson mounts have been dubbed "wasp wagons." Brig. Gen. G. M. Barnes, of the Ordnance Department, has commended the Maxson engineers for "material assistance in the furtherance of the national war effort." And these mounts have made it possible for men on the ground to win duels with Hitler's airmen in Italy.

German antiaircraft gunners in Italy used a mount carrying four 20-millimeter guns but requiring a larger crew. Two men are needed to aim the guns—one to raise or lower them and another to swing them horizontally. Those gunners, furthermore, must stand outside the mount without the protection of armor.

An American wasp wagon carries only one gunner, two cannoneers, a driver, and the squad leader. When in motion, the squad leader sits beside the driver and watches the sky ahead; the gunner rides backward and guards the rear, while the cannoneers face each other, one looking to the right and the other to the left.

If a plane is sighted, the cannoneers spring to the sides of the gun mount. Each of them is responsible for keeping two machine guns fed with ammunition and responsive to the trigger switches. The squad leader stands behind them and studies the approaching plane, to determine whether it is friendly or hostile, while the guns are being readied.

The gunner sits comfortably in an adjustable canvas seat which he can whirl around like a swivel chair. There are two machine guns on each side of him and shields in front that revolve with him.

He sees his approaching target through a glass plate, onto which a dot and two circles are projected from a little lamphouse and lens over his head. The dot shows him when he has his four guns trained on the target. The size of the plane's image within the circles on the glass enables him to estimate its distance, and he calculates its speed as he follows it across the sky.

The guns follow every movement of his hands. If he swings the two pistol-like handles which he grips to the left or right, he changes a set of pulleys connected by a V-belt, and the motor in the base below him turns him and the guns. If he tilts the handles, he changes another set of pulleys linked the same way, and the motor elevates or lowers the guns. Portable power for the motor is provided by storage batteries and a little gasoline-powered generator.

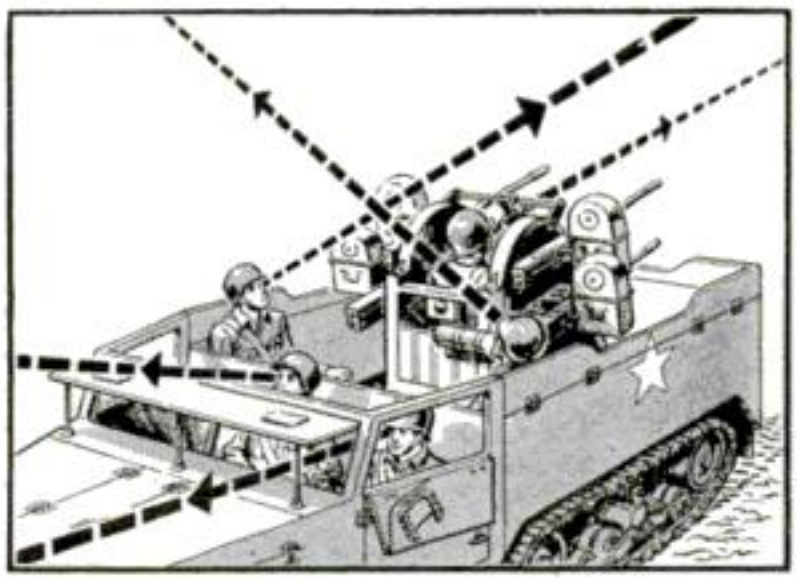
The gunner can swing his guns 60 degrees a second, either horizontally or vertically. He can do a complete about-face, and point his weapons straight up or 10 degrees below the horizon. When the guns are pointed down, the armored sides of the truck are dropped. When the guns are swung around so as to bring the driver's place into the line of fire, a safety device prevents them from firing.

The squad leader signals for action as soon as he is sure the plane sighted is hostile. Then, as the airman comes into range, the gunner tightens his grip on the handles and the guns spurt death like four jets of water. Their effective range is 1,200 yards, and a plane can be followed down to within 150 yards. Each barrel can fire from 450 to 750 rounds a minute. Every sixth bullet usually is a tracer for the gunner's guidance. By sighting with one eye and keeping the other eye open, he can see exactly how he is doing.

Meanwhile, the squad leader watches for other attackers. When he spots a new target, the four guns can be swung on it almost instantly.

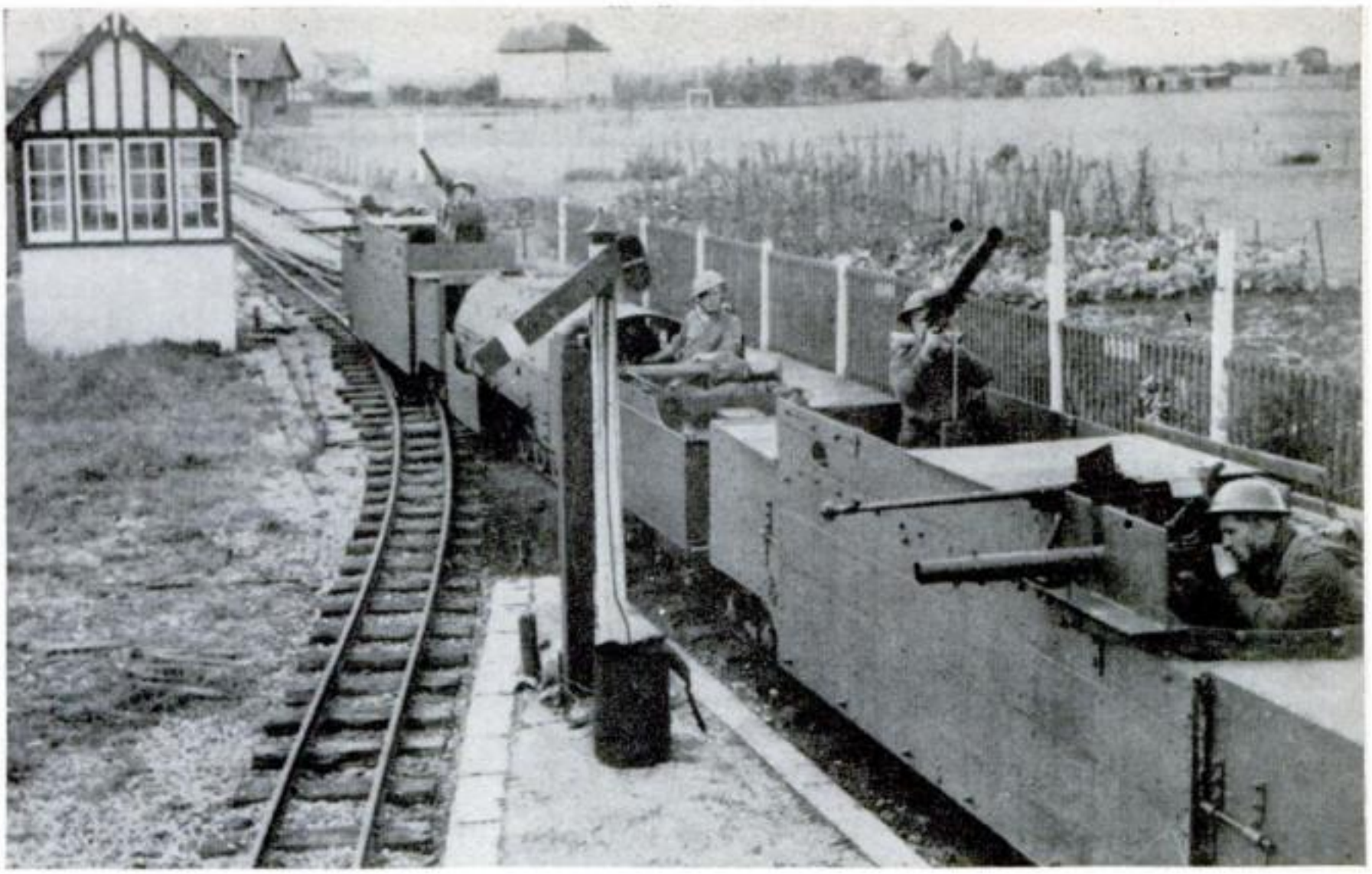
The engineering firm that Maxson started from scratch only nine years ago now employs about 1,500 people. Its sales last year exceeded $10,000,000, and sales of products designed by the Maxson Corporation but produced elsewhere totaled more than $50,000,000.

A four-gun Maxson machine-gun mount costs about $2,500. Only a few of its parts are made now by the Maxson Corporation. Most of the manufacturing has been done by Landers, Frary & Clark in Connecticut and the Kimberly-Clark Corporation in Wisconsin, in plants built originally for making paper, refrigerators, and other products.



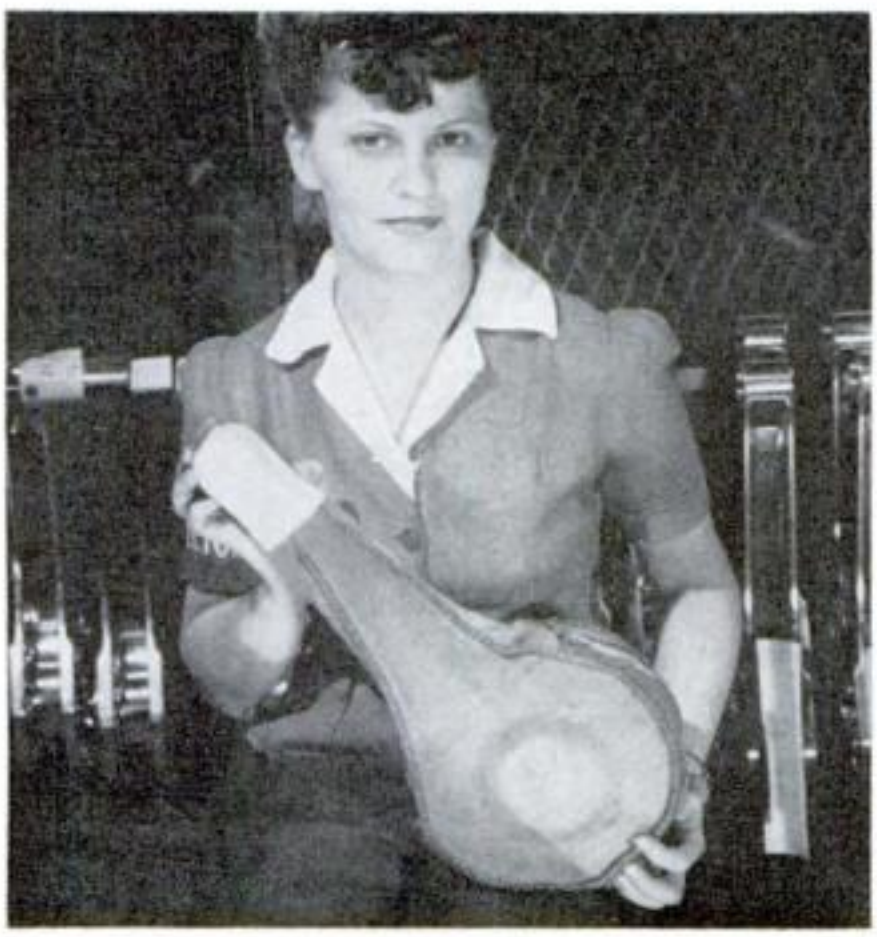
There's not much chance of a hit-and-run Axis hedge-hopper catching the wasp-wagon crew napping while on the road. In the cab, the squad leader and driver watch the sky ahead. The two cannoneers, facing each other in the truck, cover the flanks; the gunner, seated at his guns and ready for action, guards the rear

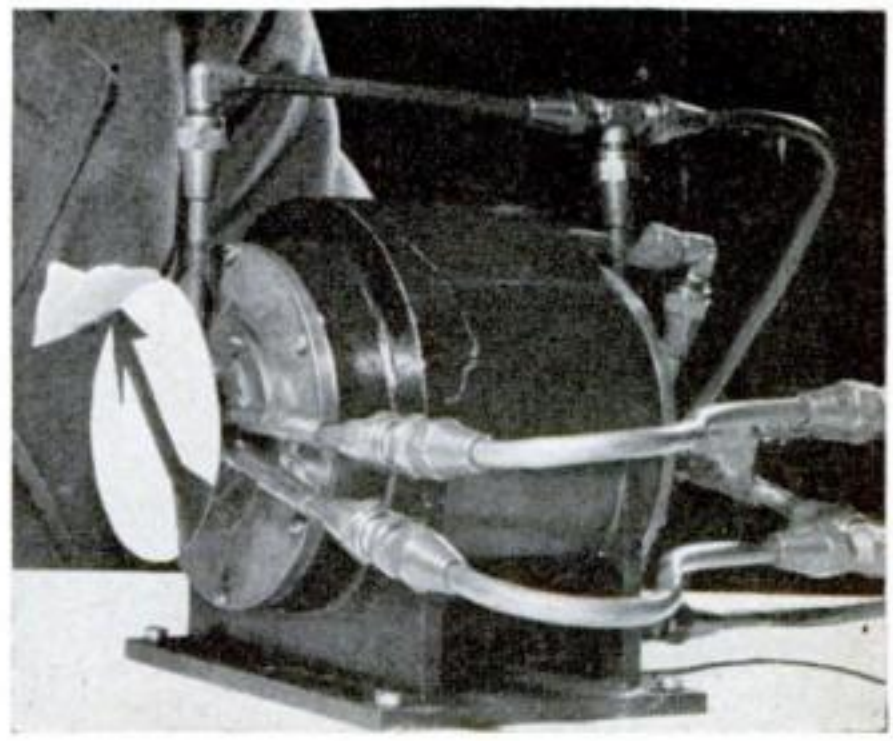
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WAR IN TOYLAND. German raiders who venture to make a landing on the Kentish coast of England will get a warm reception from this miniature armored train. Behind a puffing pint-size locomotive it patrols the narrow-gauge line of the Romney, Hythe and Dymchurch railroad, which in peace-time carried bank-holiday pleasure-seekers to coast resorts for a bit of sea air. Crouching in the tiny armored cars, British Tommies man machine guns, eager to pot any Jerry wot shows 'is bloomin' fyce.

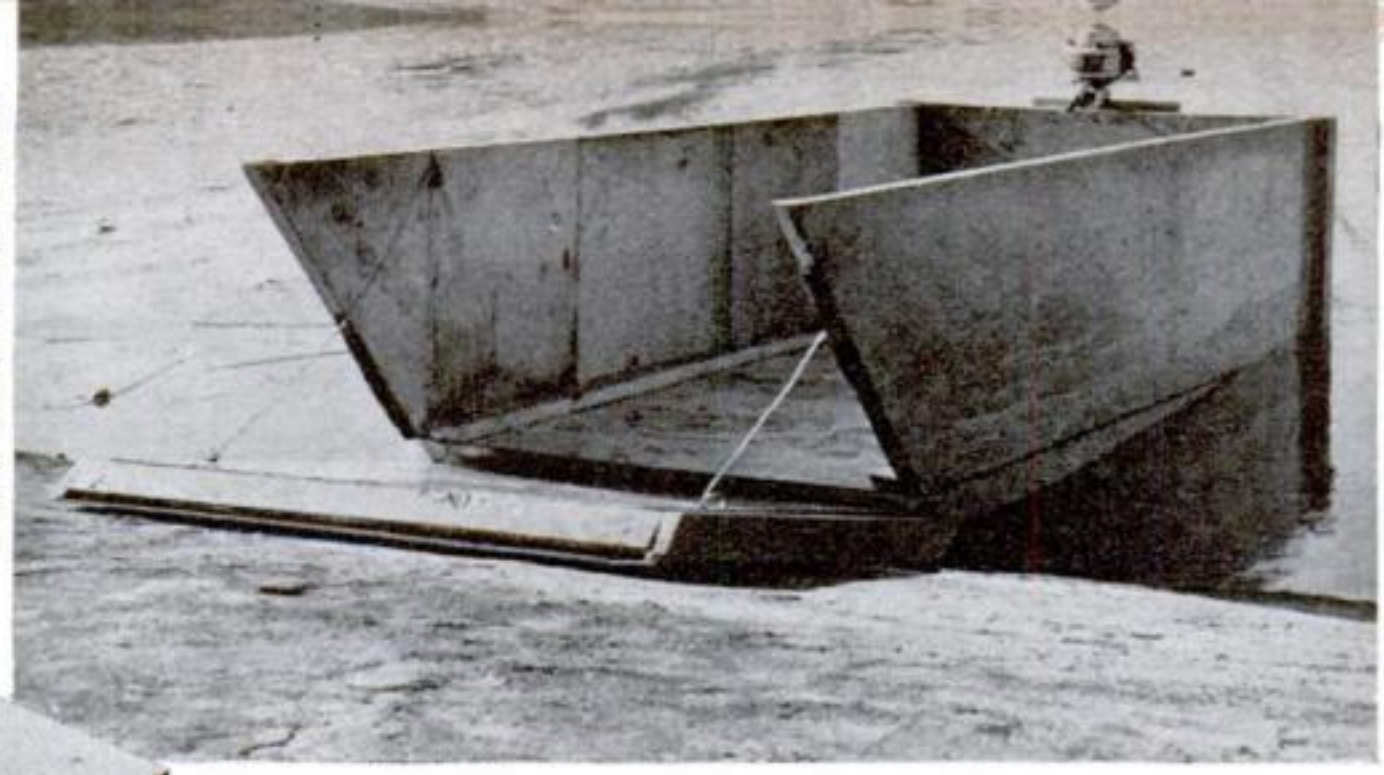
"BANJO CASES" of cloth fitted with slide fasteners are employed to protect the surfaces of airplane master connecting rods while they are being moved about in the Chicago plant of the Studebaker Corporation. Celia Imbier, a plant inspector, is shown with one of the "banjos" on her knee.



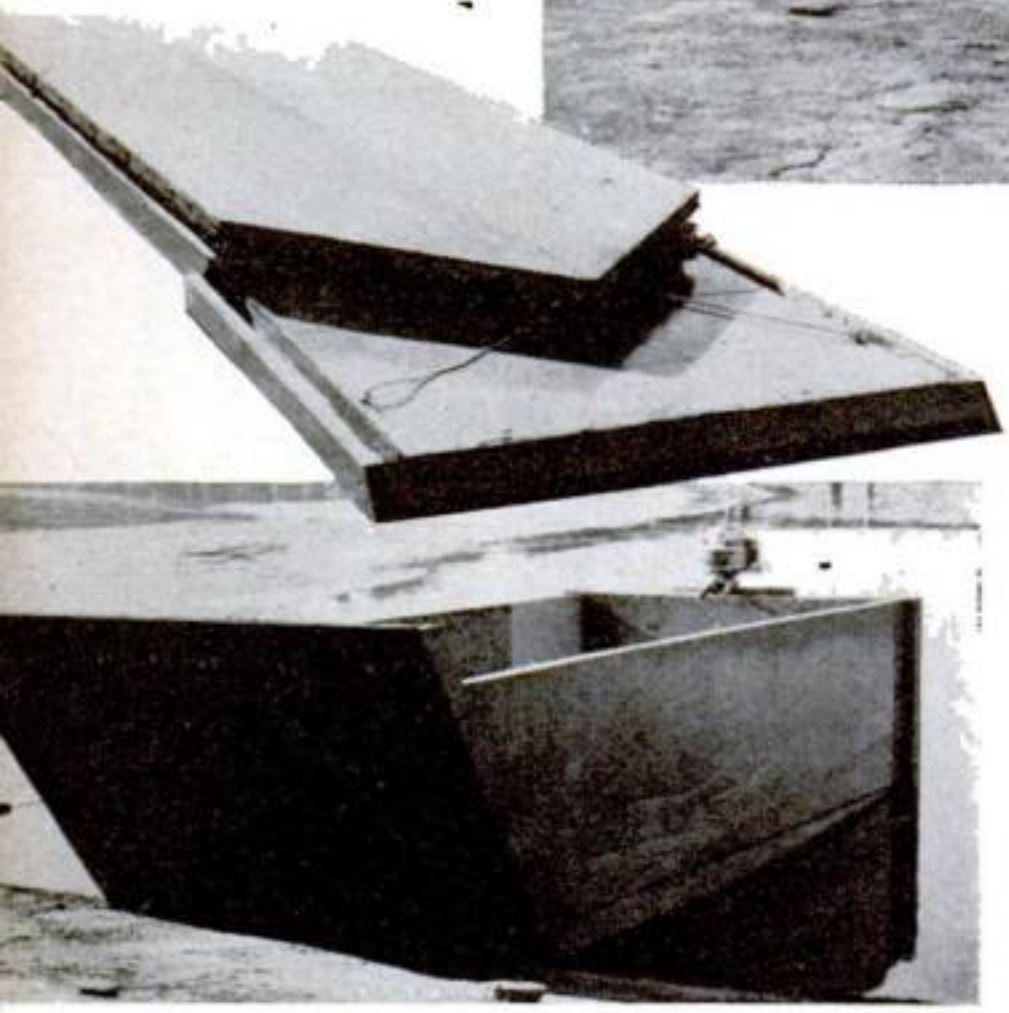


1,000 REVOLUTIONS A SECOND is the amazing speed of this small electric motor designed by Robert M. Baker, of Westinghouse, for grinding hard-to-get-at surfaces of tank and plane engines. Connected directly to the grinder, the motor produces the high speeds necessary for the smooth and effortless cutting required in precision work involving tolerances of a few millionths of an inch. At its outside edge, the revolving part travels more than 300 m.p.h.

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A half-size rough model illustrates the principle on which the collapsible assault boat is built. The hinged front, sides, and stern fold flat on the bottom, as shown below, for transportation in about a sixth of the space taken by a regular boat. The bow can be lowered to form a ramp for landing men on a beach



Full-size boats, 24 feet long and 10 feet wide, will be driven by one or two outboard motors. Unfolding of a boat takes about three minutes and requires no bolting. The sides and bottom are made of marine plywood

COLLAPSIBLE ASSAULT BOATS which fold flat for transportation on shipboard are being built by the Travelodge Corporation, of Lynchburg, Va., peacetime makers of prefabricated buildings. Continuous hinges along front, sides, and back enable these parts to lie flat on the bottom, so that about six of the collapsed boats can be carried in the space that would be required for one ordinary boat of similar capacity. Sides and bottom are single pieces of marine plywood nailed and glued to studs; the bottom forms an air pocket which gives added buoyancy for heavy loads. At the scene of a landing, some three minutes are required to transform one of the flat packages into a boat ready to be driven ashore by one or two outboard motors. No bolting is necessary. The makers point out that an invasion transport could carry enough of these collapsible boats to send all its troops ashore in one trip, thus avoiding shuttling.



BELL AIRACOBRA
(P-39)
U. S. ARMY FIGHTER

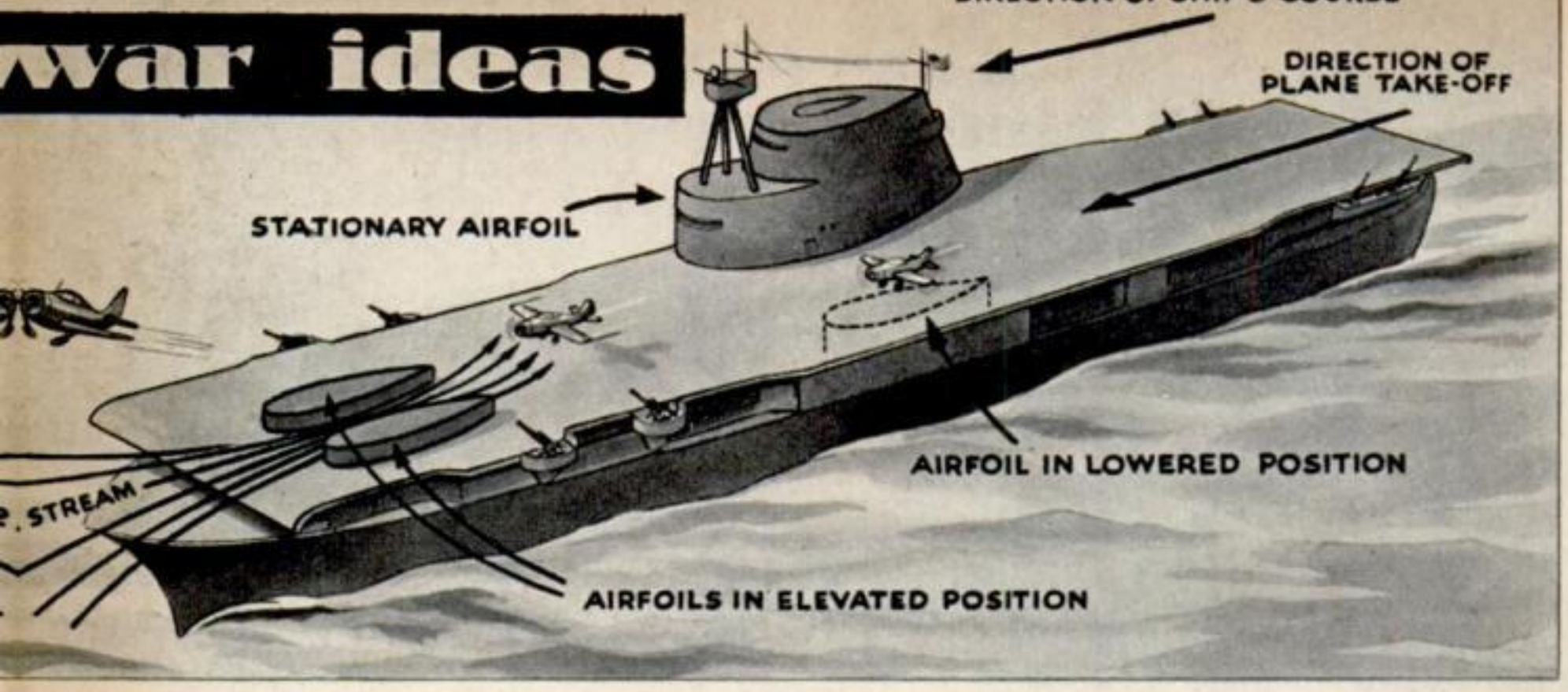
TERROR of Axis armor and motorized equipment, the Bell Airacobra is a plane that grew around a 37-millimeter cannon. Its 1,150-horsepower Allison liquid-cooled engine rides behind the pilot, with its shaft running between his legs to a gear box in the nose. Jo Kotula's brush has caught the P-39 in a mission to strafe a truck convoy.

NEXT MONTH: *CONSOLIDATED PB2Y CORONADO*

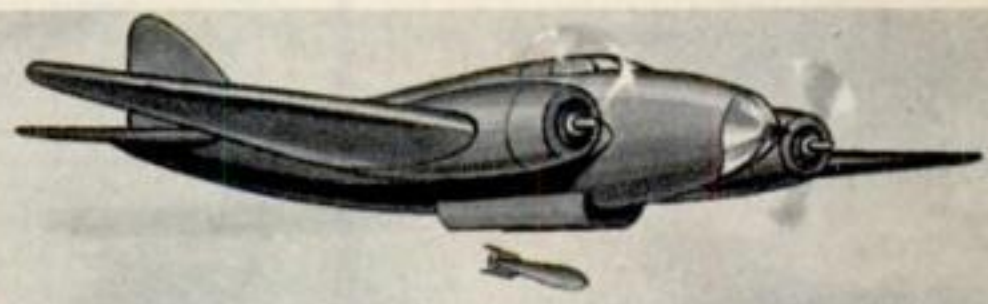
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war ideas

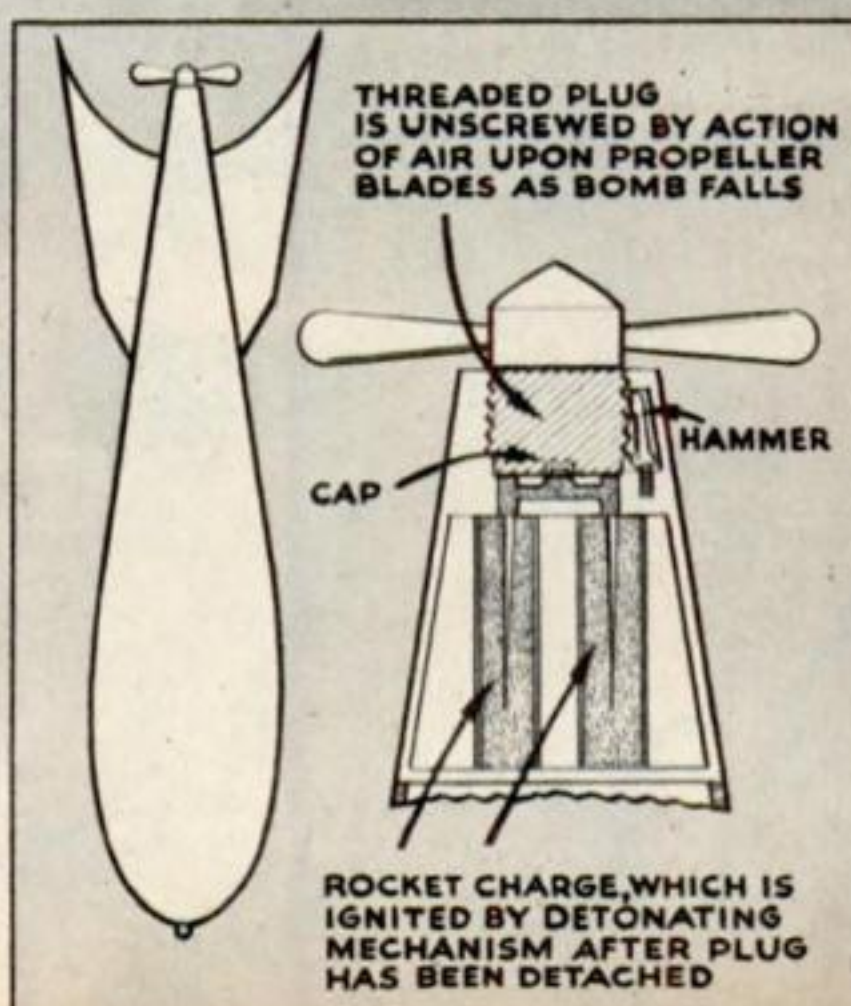


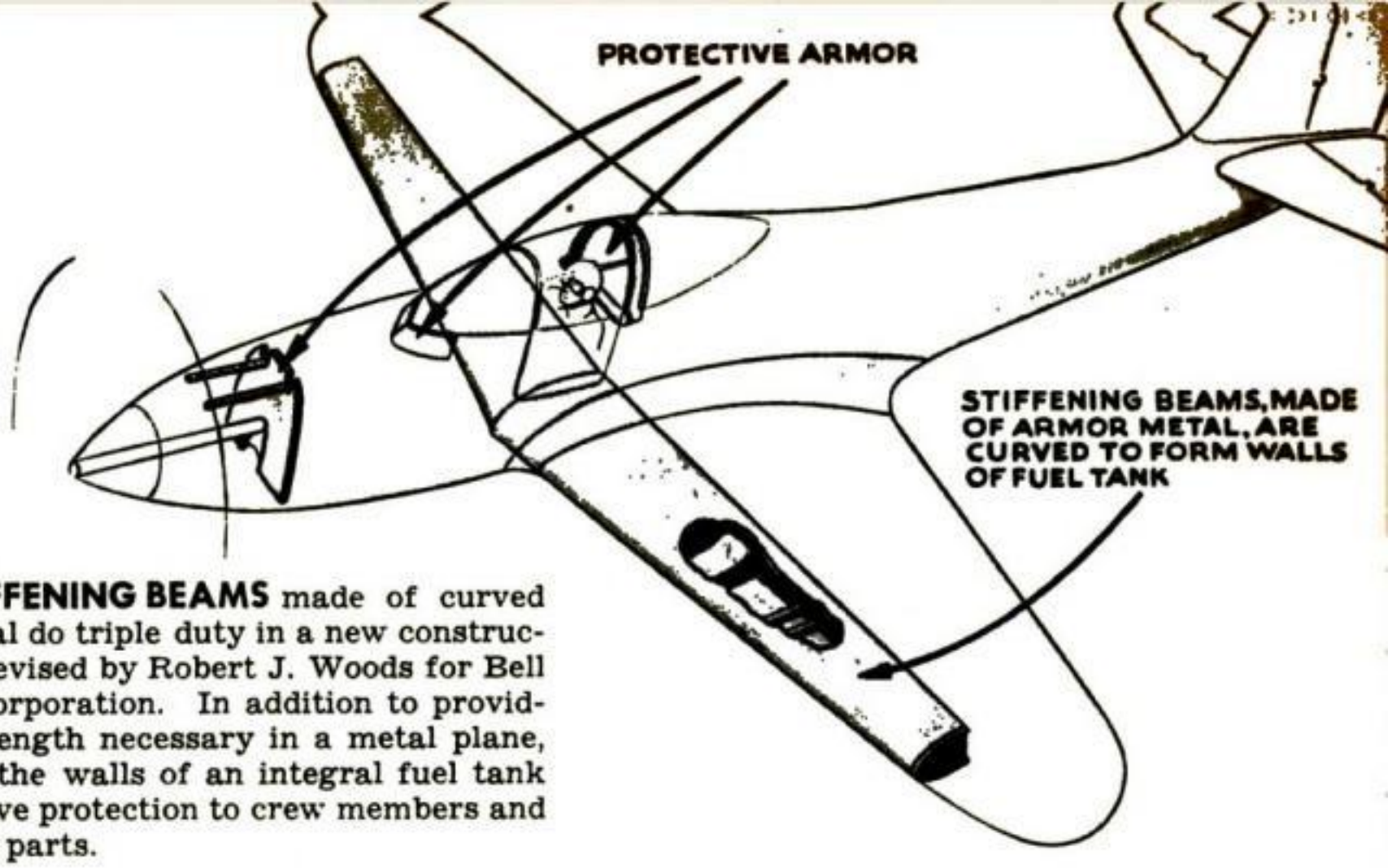
QUICK TAKE-OFFS can be made even by heavy bombers after a short run on aircraft carriers equipped with this new launching device, according to Franklin W. Durgin, Washington, D. C., inventor. Increased lift to get the planes up quickly is provided by "amplifying" the breeze created by the ship's motion between paired airfoils that act like the familiar Venturi tube. The structures sink flush with the deck when not in use. The invention is designed to make possible the use of shorter vessels, which would be harder for enemy bombs and torpedoes to hit.



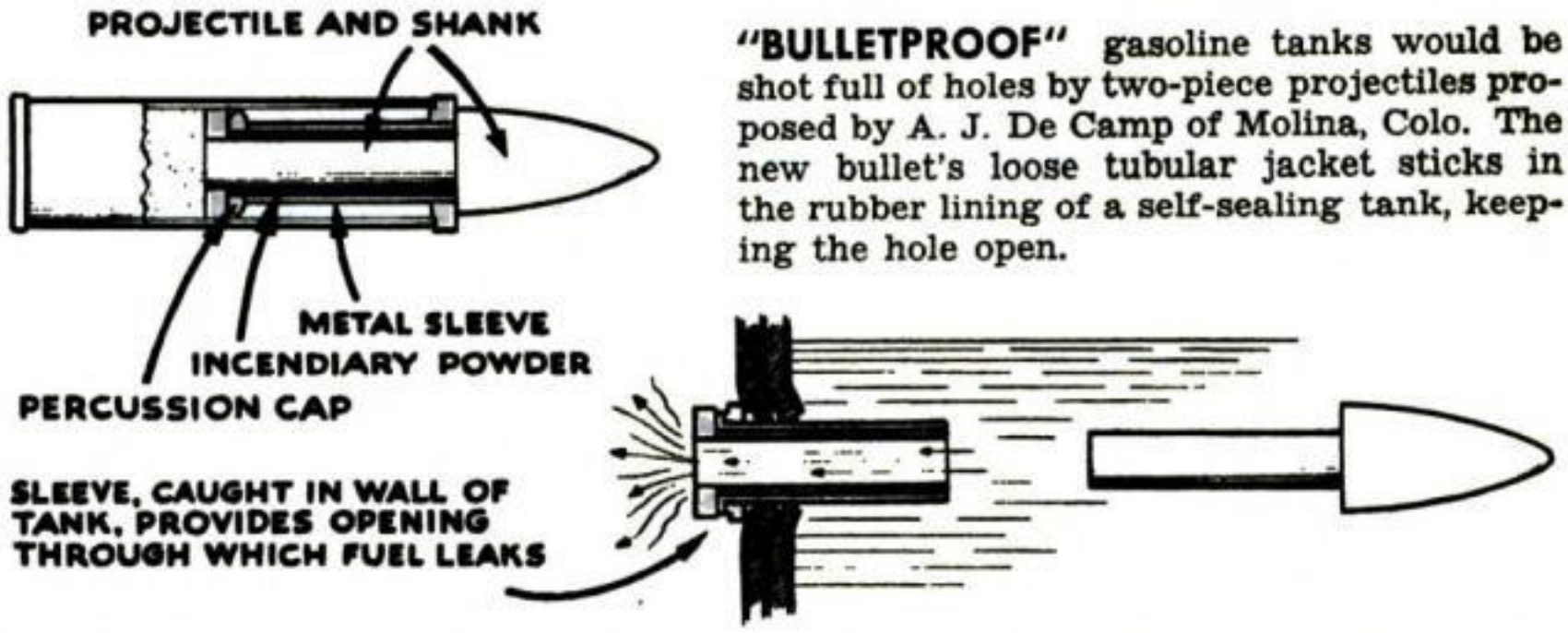


ROCKET BOMB. To send an aerial bomb downward at high, armor-piercing velocity, W. F. Rouse, of Havelock, Iowa, proposes a series of rocket jets in the tail. A safety igniter, operated by a propeller, sets the rockets off after the missile has fallen clear of the plane. This is the first American-designed weapon of its type, although "upside - down" rockets something like it were reported in use by the Germans some time ago. The relatively low terminal velocity of bombs that rely on gravity alone not only makes them ineffective for penetration of modern armor or the thick concrete walls of forts, but also makes them harder to aim accurately, the inventor explains. Rocket propulsion gives the bomb a positive direction and decreases the effect of varying wind velocities on aim.





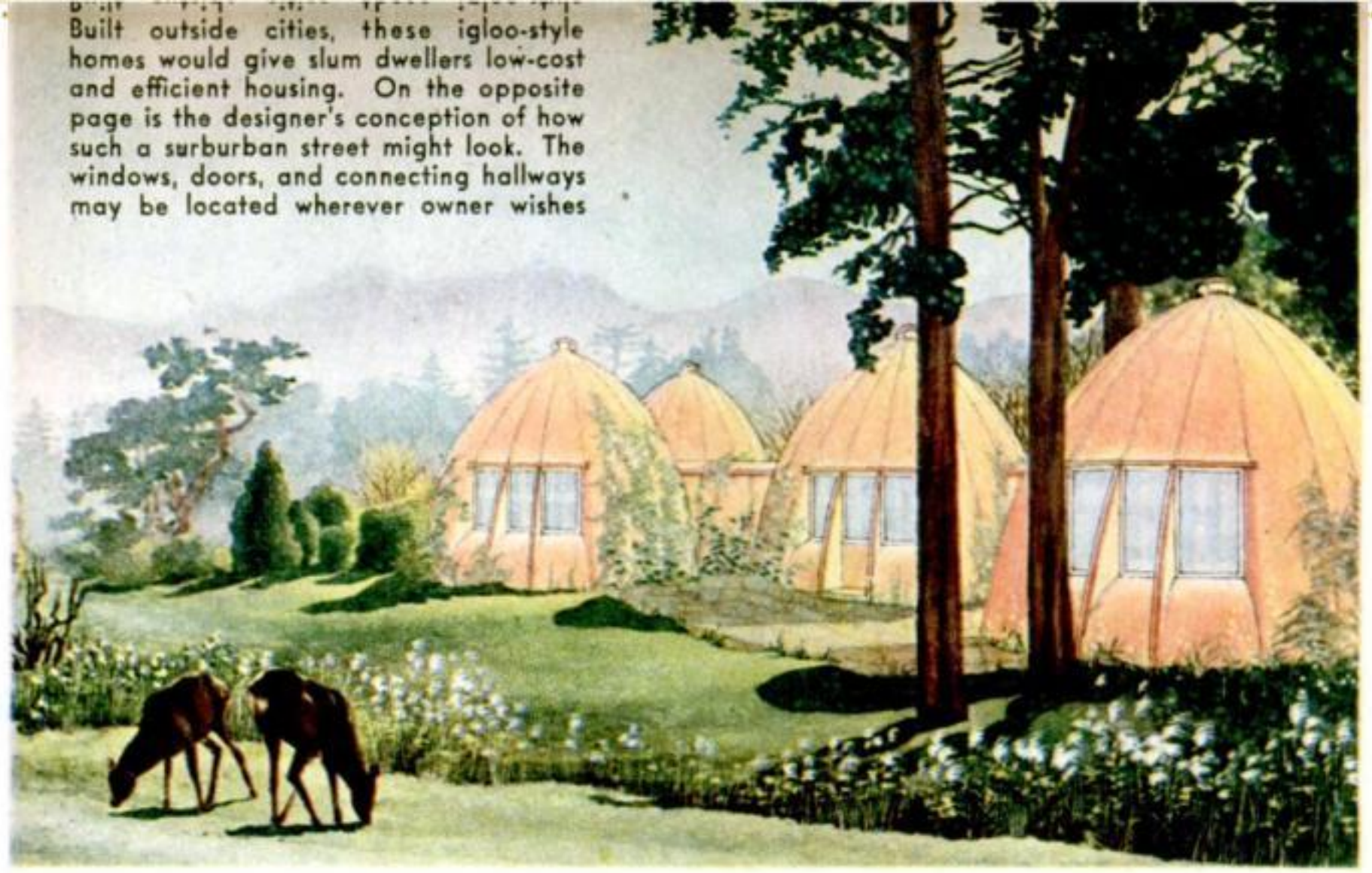
WING-STIFFENING BEAMS made of curved armor metal do triple duty in a new construction plan devised by Robert J. Woods for Bell Aircraft Corporation. In addition to providing the strength necessary in a metal plane, they form the walls of an integral fuel tank and also give protection to crew members and vital plane parts.



"BULLETPROOF" gasoline tanks would be shot full of holes by two-piece projectiles proposed by A. J. De Camp of Molina, Colo. The new bullet's loose tubular jacket sticks in the rubber lining of a self-sealing tank, keeping the hole open.

A PERISCOPE FOR TANKS has been invented by an Army officer, Lt. Col. David J. Crawford, to overcome one of the greatest handicaps faced by tank commanders—the near blindness caused by the narrowness of the sight slits in a tank's armor. The officer using the periscope sits with his face six inches from it, using both eyes to see a section of terrain nearly as wide as an outside view. When he sees a target, he closes his left eye and sights through an aiming telescope, which is part of the apparatus. Gun and periscope are rotated simultaneously until the target appears in the reticule of the telescope, when the gun is fired. The exposed mirror of the telescope is easily replaced if shattered.

ABBOTT GRIFFIN



Built outside cities, these igloo-style homes would give slum dwellers low-cost and efficient housing. On the opposite page is the designer's conception of how such a surburban street might look. The windows, doors, and connecting hallways may be located wherever owner wishes

Would you Live in a STAINLESS-STEEL IGLOO?

These heavily insulated steel shells are a new approach to the housing problem. Low in cost and portable, they give a wide flexibility of layout.

By

FRANK ROWSOME, Jr.

"YOU can't make an electric light just by perfecting a wax candle." So says Martin Wagner, Harvard professor and internationally known architect, in explaining how he conceived the unique igloolike houses shown on these pages.

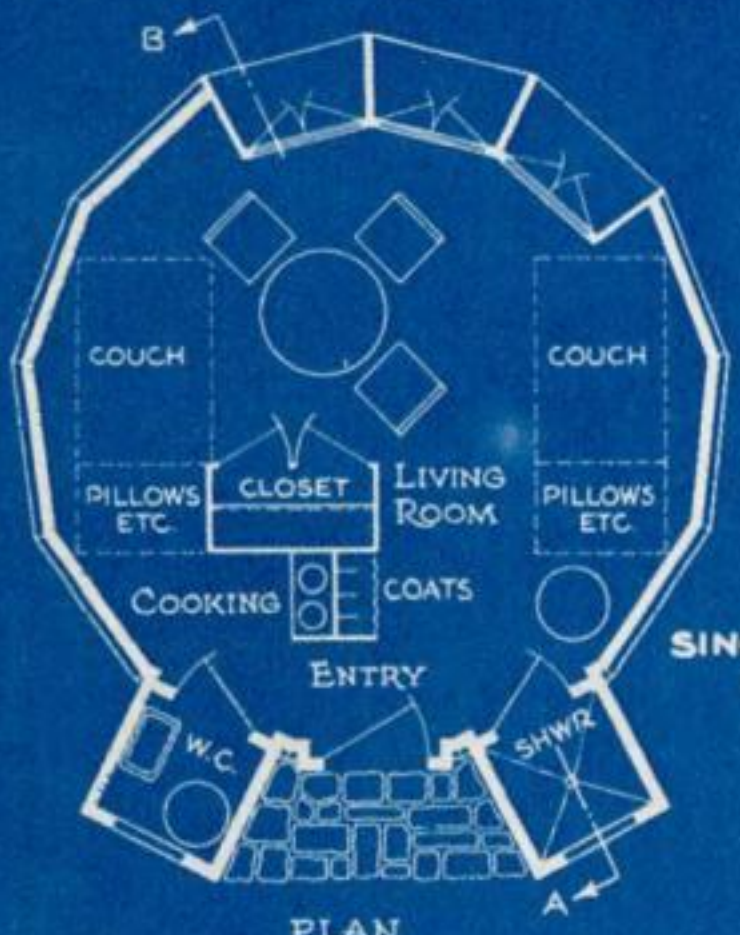
Most modern prefabricated houses, Wagner asserts, are at the same stage of development that automobiles had reached when their builders were trying to make them look like buggies. In his opinion, a steel, plywood, and plastic house that is produced in a factory should not merely imitate wooden, carpenter-built houses. Instead, it should make full use, in form as well as construction, of new materials and new techniques.

In his design every room is a house in itself, connected with another room by a short hall. Each 13-sided unit is made of steel-sheathed plywood, liberally insulated with glass wool. Because a structure of conoidal shape is from an engineering viewpoint already in a "state of collapse," the house is practically proof against hurricane and earthquake. Built into the apex of each room is electrical heating and ventilating equipment, permitting individual control in every unit. While in an ordinary house some 15 or 20 tons of building material have to be heated or cooled for each room, it's necessary to heat or cool only three tons for one of the igloo units.

As visualized by the architect, a young couple might begin with a single basic unit which under mass production could be delivered and assembled, complete with shower and bathroom cubicles, for an estimated $670. As they could afford it, regular bedroom, kitchen, bathroom, and study units could be added. Later on, if the family decreased in size, unneeded rooms could be sold. For moving, disassembly of a unit would require only eight hours.

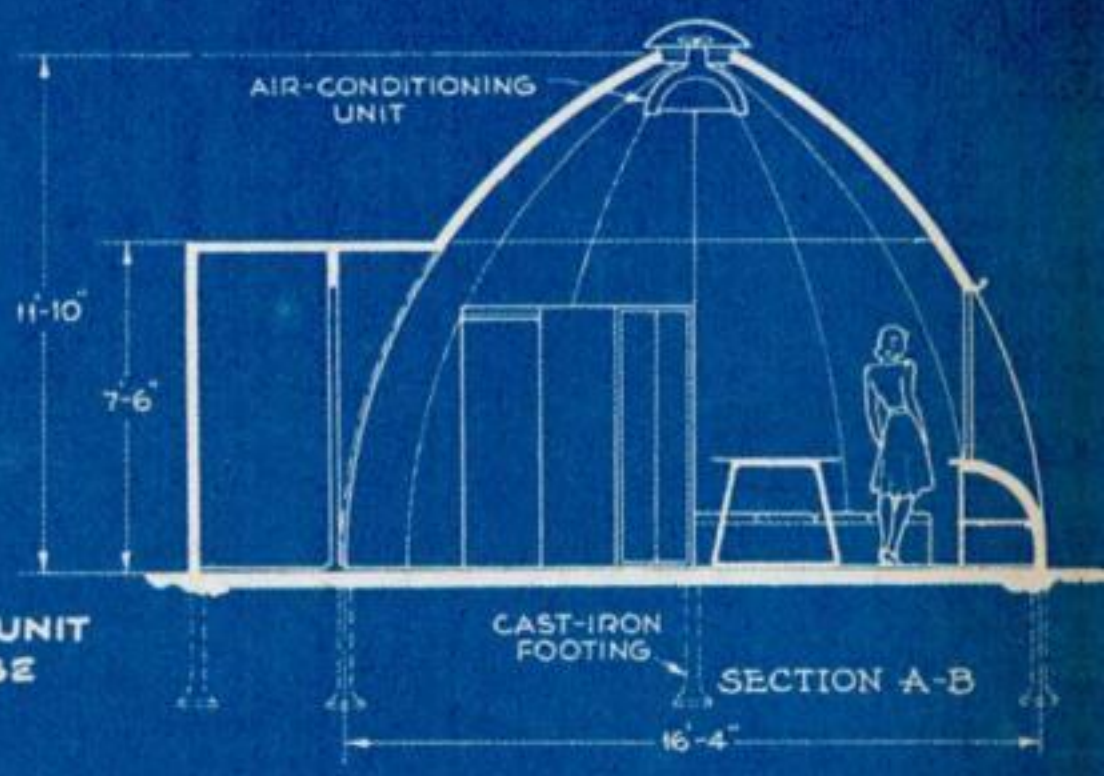
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PLAN

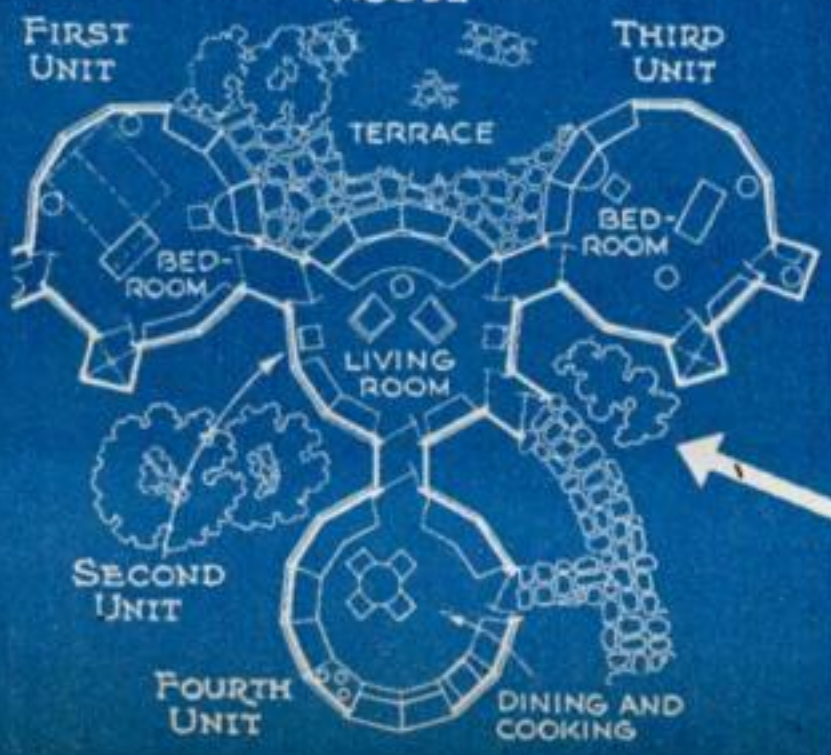
SINGLE-UNIT HOUSE

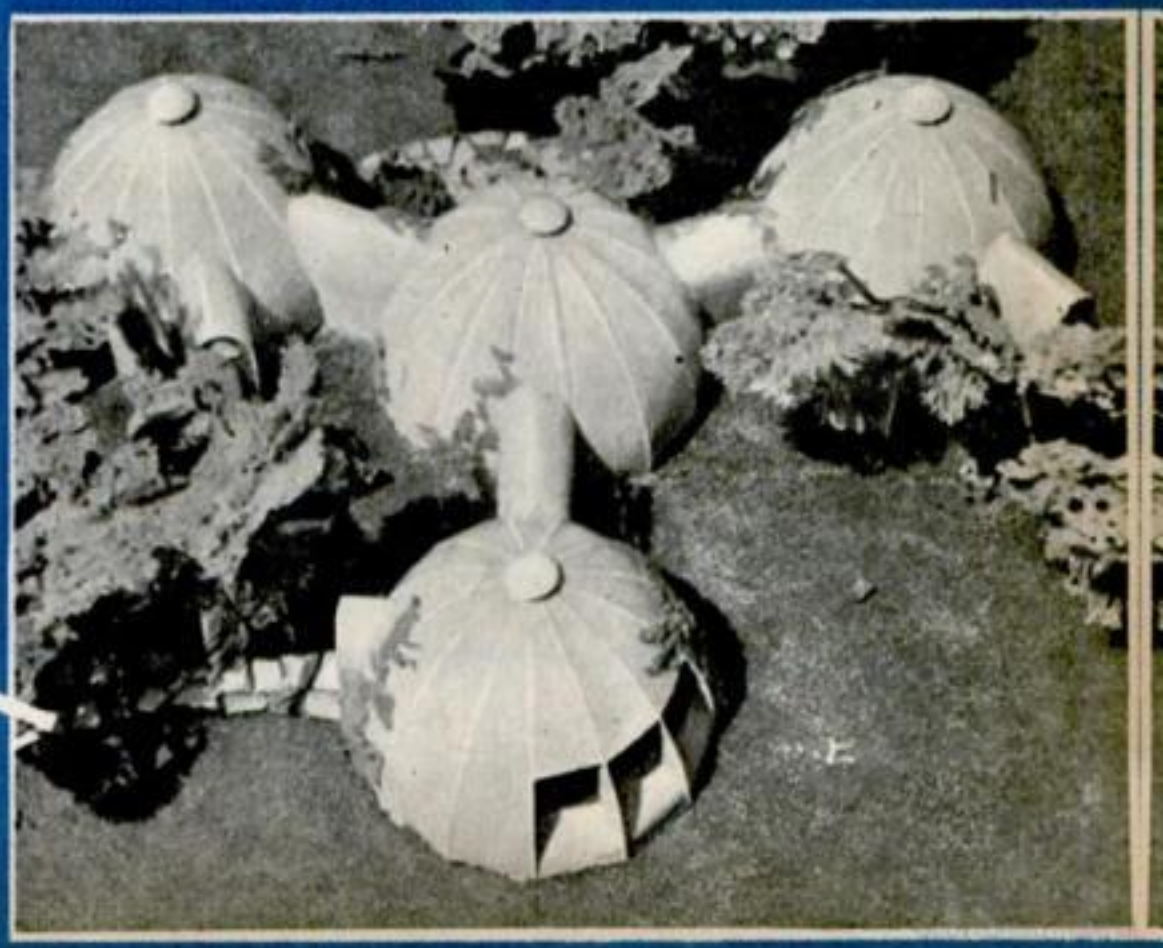


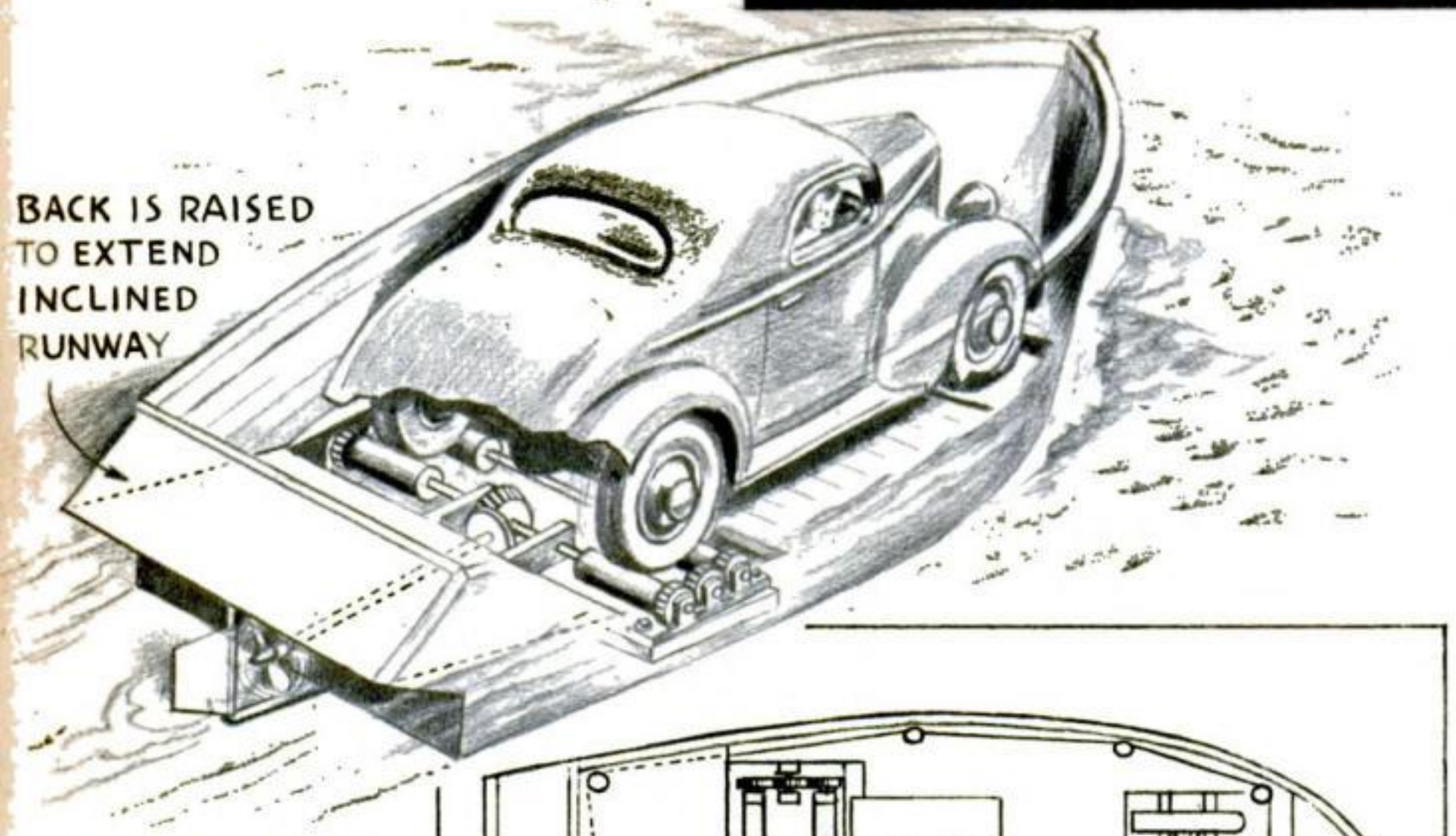
SECTION A-B

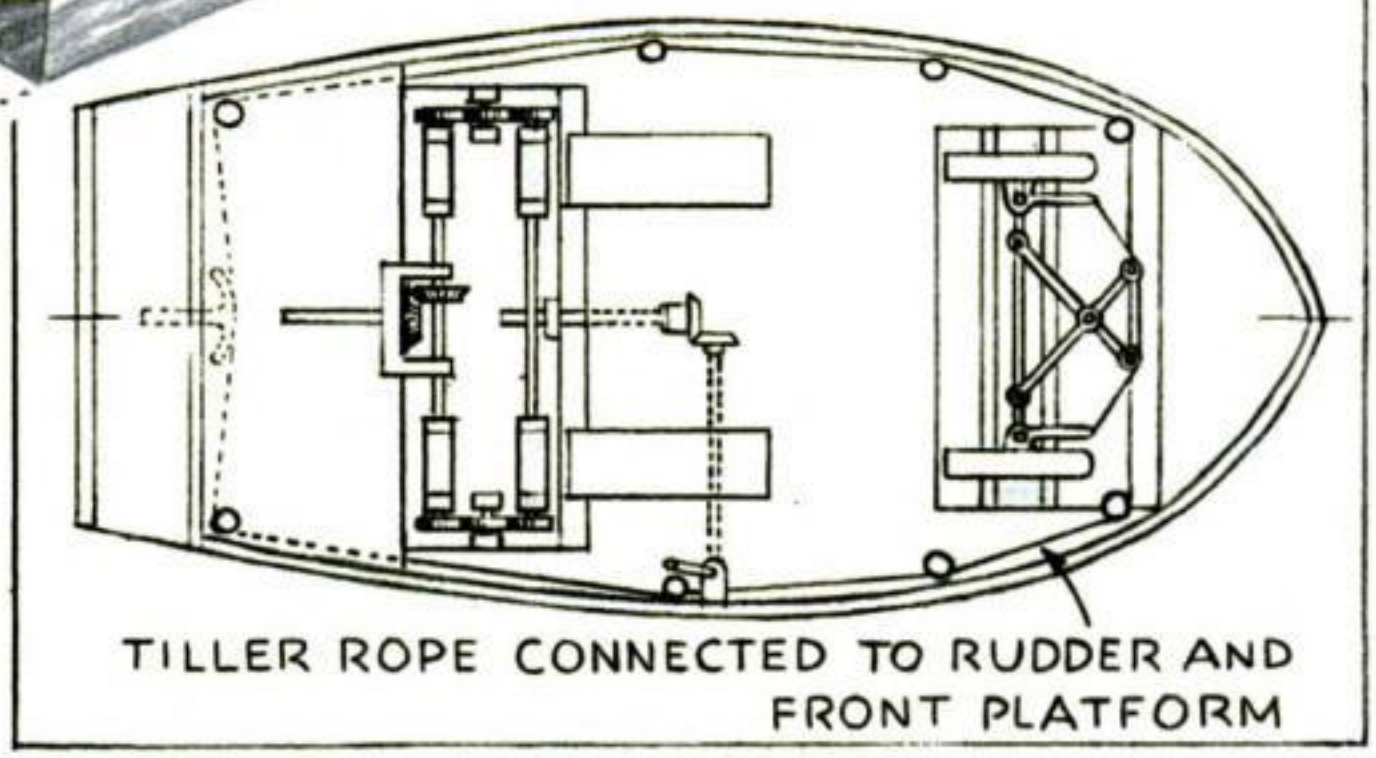
One unit serves as a livable though cramped house. As other rooms are added, the owner can tailor his home to his needs

MULTIPLE-UNIT HOUSE

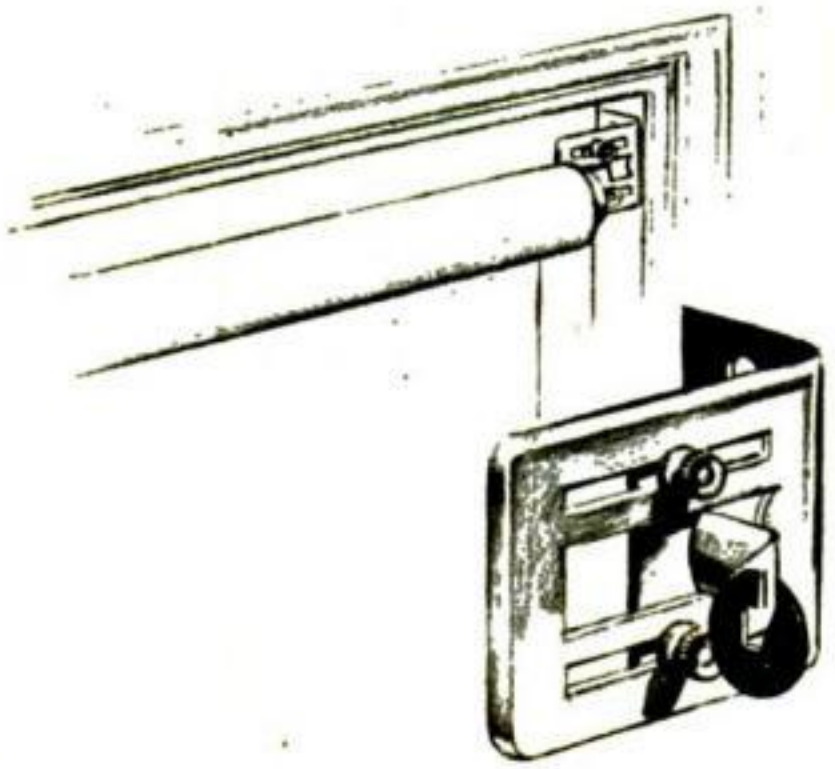








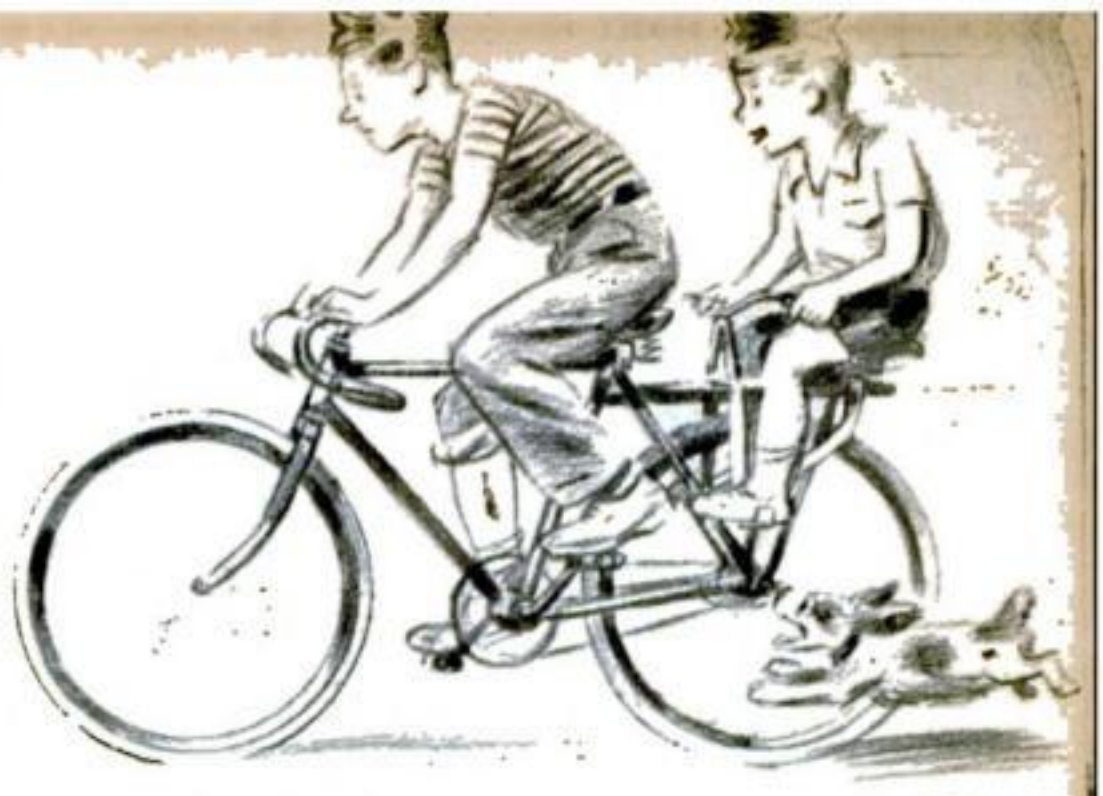
A SELF-SERVICE FERRY that an autoist can operate without getting out from behind the wheel of his car is suggested by Dmitri Kaloshin, of San Francisco. A gangplank at the stern swings down to allow the car to come aboard, where it moves into position so that its rear wheels rest on rollers through which power is transmitted to the propeller. The front wheels lock in the recesses of a turntable connected to the rudder, so that the boat can be steered from the wheel of the car.



ADJUSTABLE BRACKETS that can accommodate window-shade rollers of varying dimensions have been devised by Joseph J. Burgess, of Brooklyn, N. Y. As illustrated, the roller holder extends from a vertical bar fitted with thumb screws that slide in horizontal slots. Once the bar of each bracket has been adjusted for a given roller, it can be firmly secured in that position by tightening the thumb screws.

A GRID that is easily attached to or removed from a frying pan has been designed as a temporary shelf on which bacon and similar foods can be kept warm while being drained of their grease. Developed by W. P. Shepherd, Pasadena, Calif., the flexible wire grid fits pans of any size.

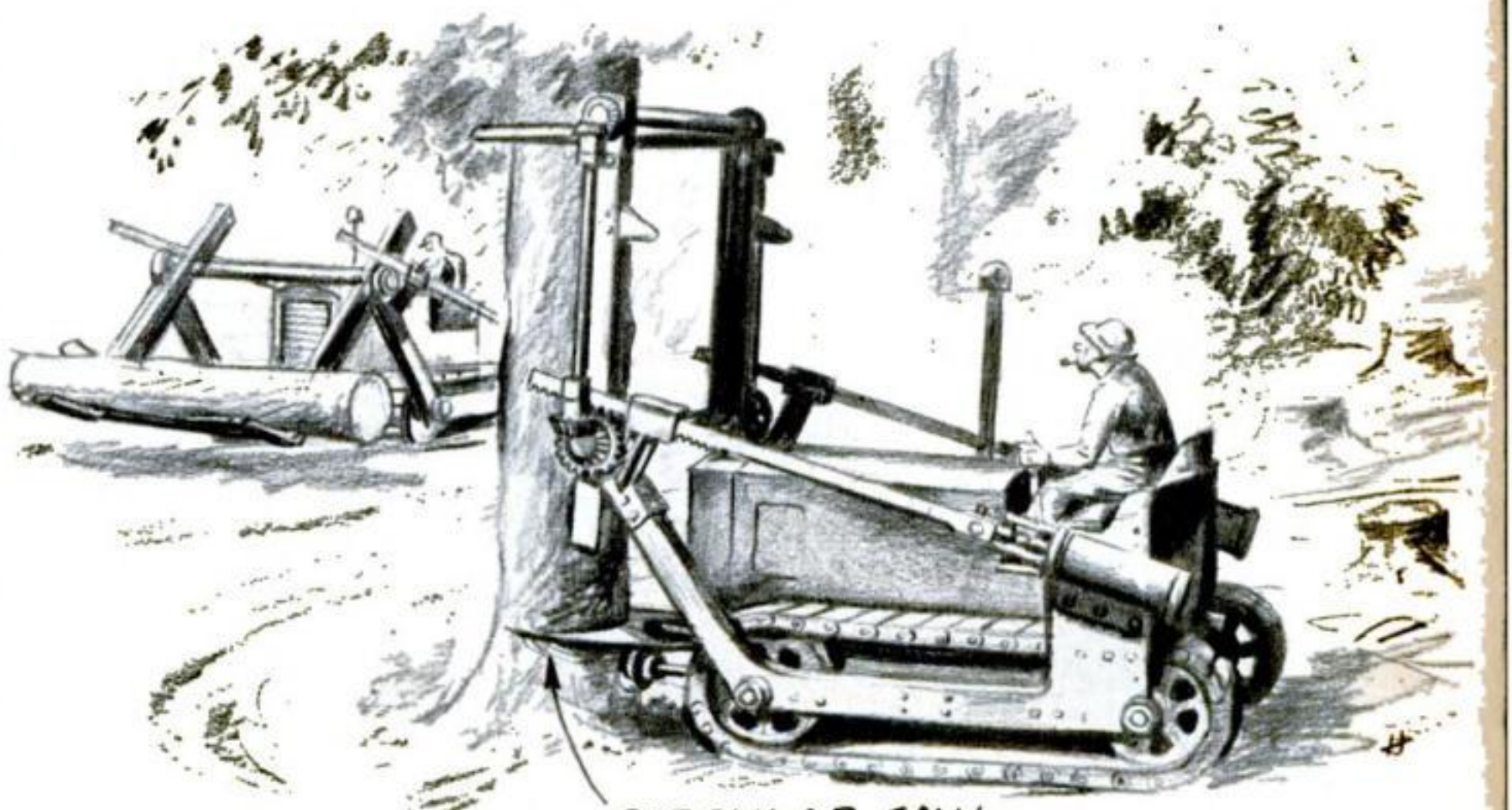




BIKE FOR TWO. One answer to the transportation problem is this "rumble seat" consisting of a saddle, a pair of foot rests, and a dummy set of handle bars—all mounted on a frame that is supported by the rear-wheel hub. Designer is L. J. Belanger, of Graniteville, Vt.



MECHANICAL TREE FELLER. A tractor-mounted, Diesel-driven machine has been developed by a city-dweller — Zygmunt Pehel, of New York City—to do much of the work that formerly could be done only by lumberjacks. A circular saw projecting from the tractor can be adjusted to cut a tree at a variable height from the ground. After the tree has fallen, the saw can be turned at a right angle to cut off large limbs or to saw the tree into short logs. At this point, the geared derrick-like boom, which is operated by pistons extending from pneumatic or hydraulic cylinders at the rear of the tractor, may be used to carry and load the lumber.



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Tell What to the Marines!

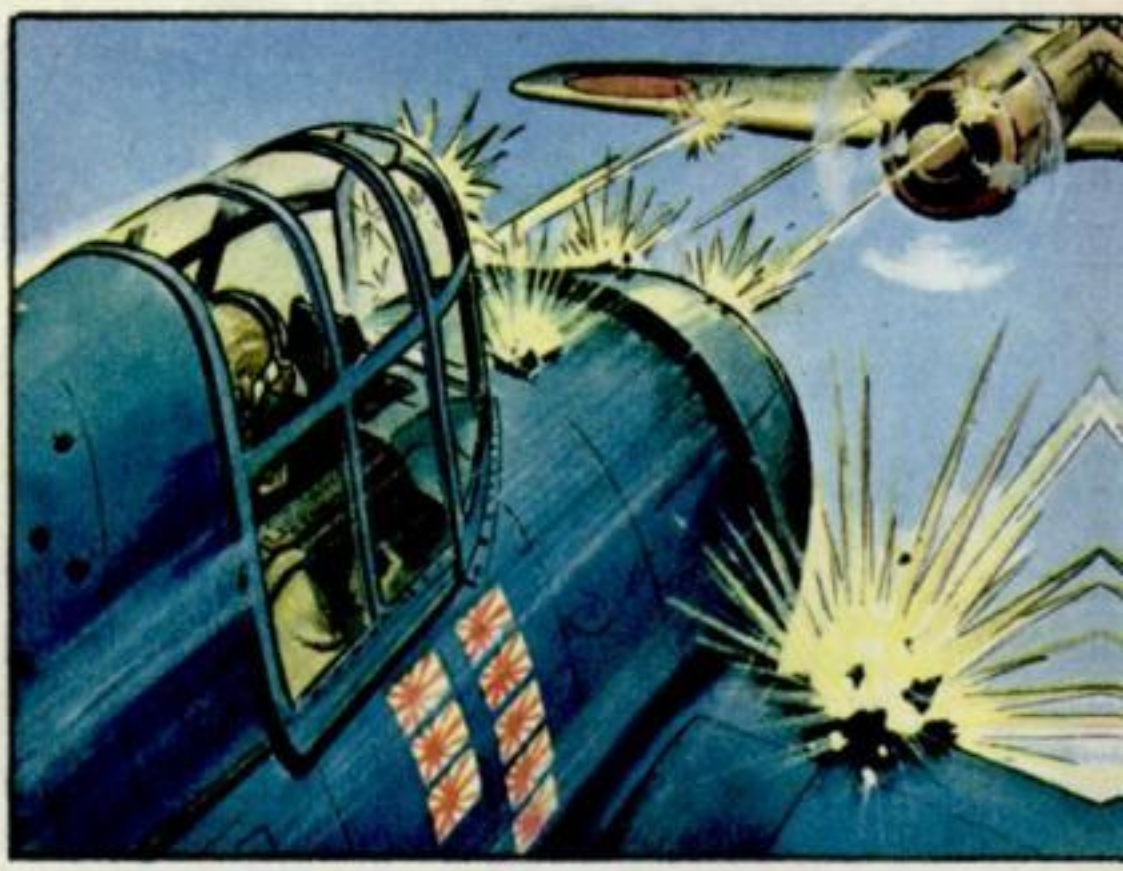
By FRANK TINSLEY



Officially credited with eight enemy planes during the early Guadalcanal fighting, Lt. Jack Conger of the flying Marines thought he knew something about aerial excitement. . . . But a hair-raising half hour over the Solomons added a whole bevy of new thrills to his collection. Here's the story:



3 Jack slapped a burst into one of the surprised strafers, then wheeled and downed another just off the beach. Suddenly a third Zero joined the party!



4 "We were headed for each other, firing like all hell," Jack tells it, "when I ran out of ammunition! I kept right on going, though!" . . .

7 As he shot the CO_2 to his Mae West, another canopy loomed over him and a Jap hit the drink not 20 yards away!

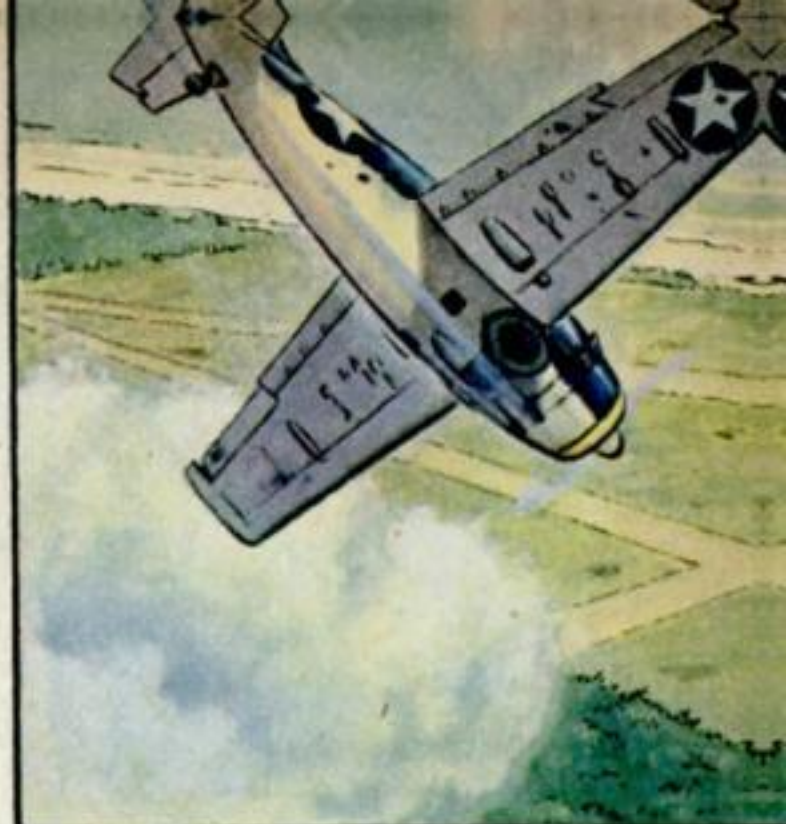


8 Being a bit partial, the crash-boat crew fished Conger out first, then went after the Jap. The son of Nippon ducked and dodged until Jack snagged the boat hook into his life belt.

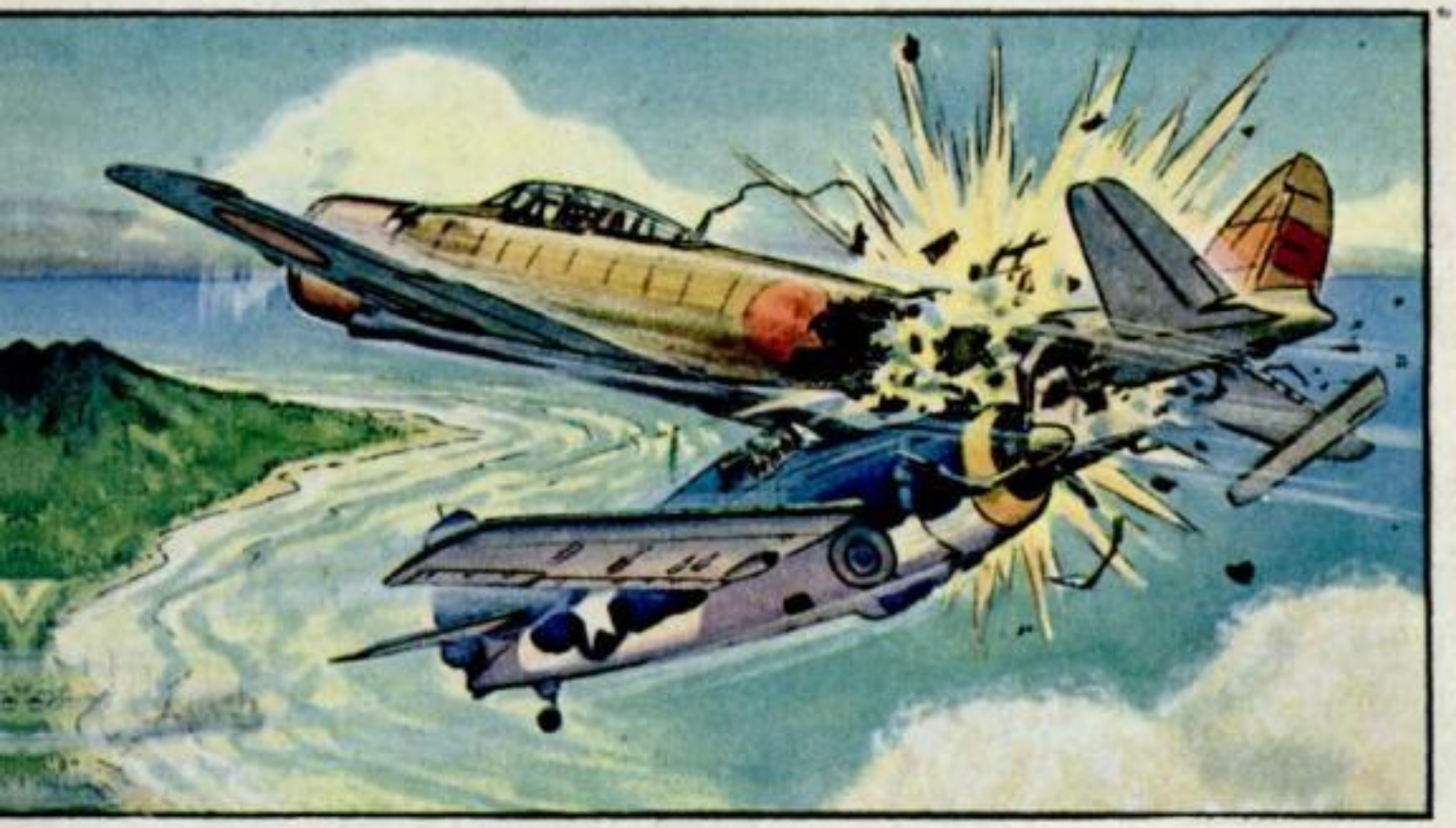




1 Conger took off from Henderson Field with a welcoming committee to greet a visiting Jap flotilla. The odds were typically Marine: four tiny Wildcats vs. three big destroyers!



2 Returning to Henderson with a pal J who was out of calling cards, he s saw a flock of Zeros hazing ground crews. .



5 "I figured I might be able to nose up as he went over me and chew off his tail. I must have been kinda excited, for I pulled up too fast. The prop nipped Nippie about five feet in front of his tail . . . WHAMMO!"

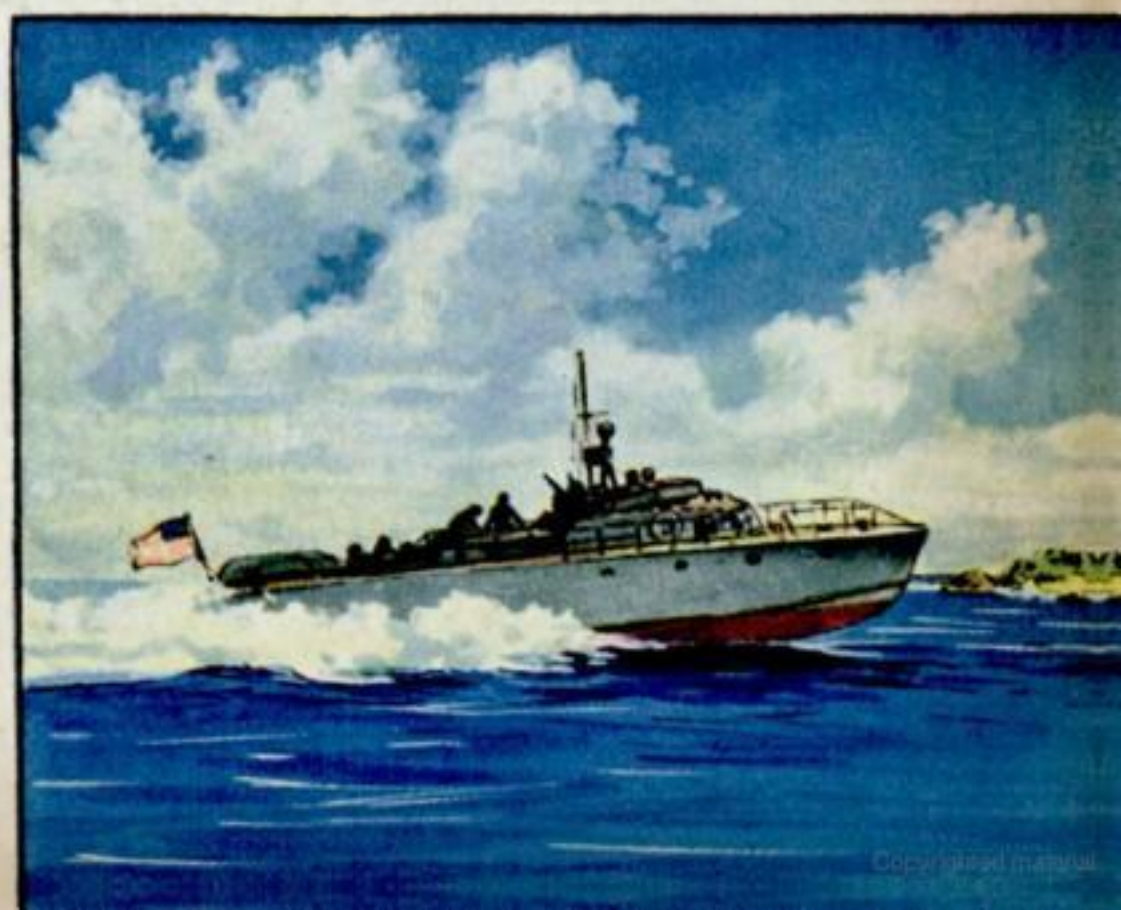


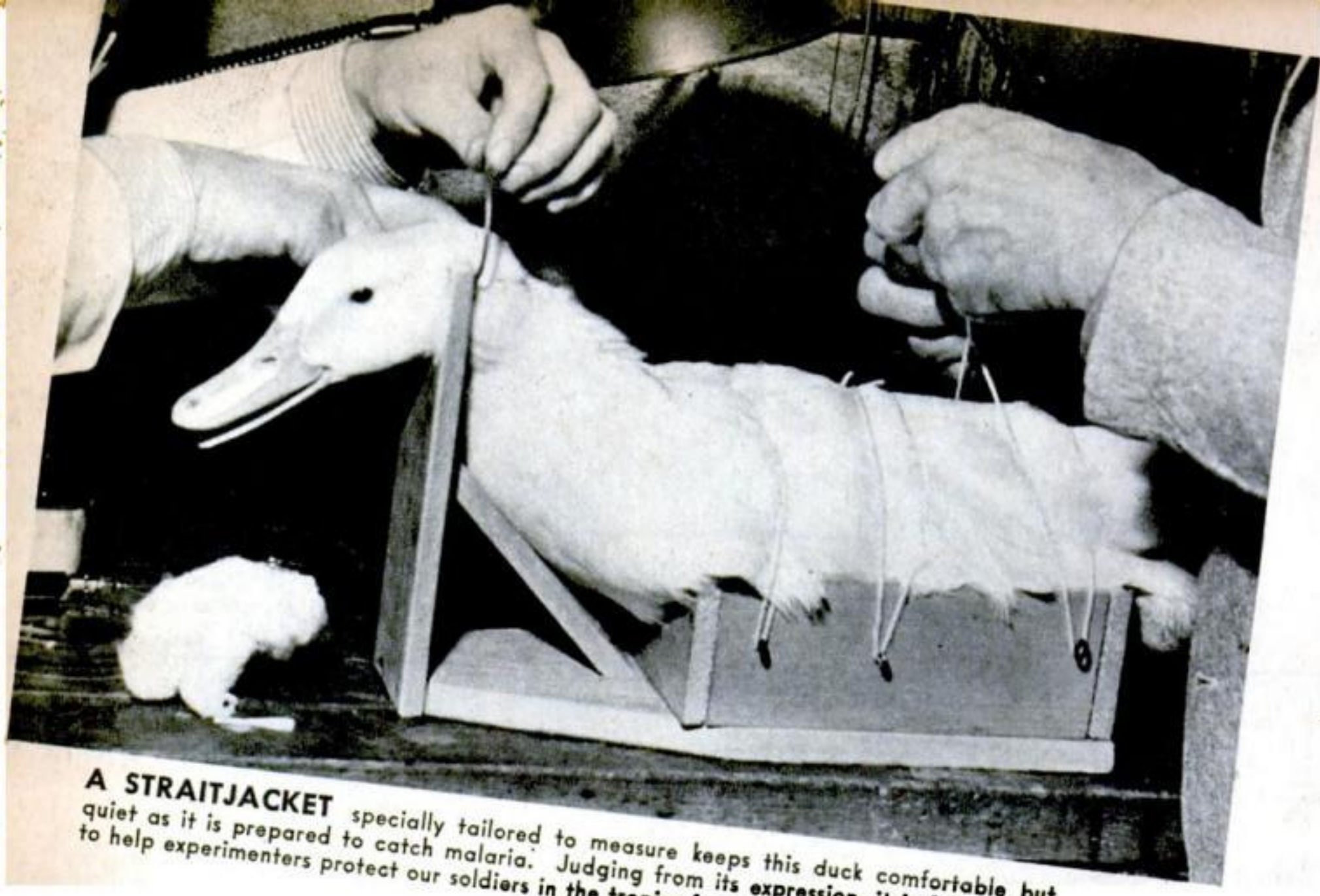
6 As the Zero hit the water in two pieces, Jack kissed the wrecked Wildcat goodbye. . . .

9 When Conger pulled him aboard, the Nip shoved a pistol into the Marine's face and pulled the trigger. The gun missed fire!

10 "I dropped both hook and Nip." Jack says. They finally knocked the Jap over the head and dragged him into the boat again. Ashore, Conger went to the field and turned in!







A STRAITJACKET specially tailored to measure keeps this duck comfortable but quiet as it is prepared to catch malaria. Judging from its expression, it is fully willing to help experimenters protect our soldiers in the tropics from flank attacks by the disease

Ducks Aid War on Malaria

STRAPPED in a harness that keeps it from ambling away, a laboratory duck becomes a subject for warfare against malaria, under the direction of Dr. Morton Kahn at the Cornell University Medical School, New York City. For two hours the fowl patiently submits to bites of malaria-infected mosquitoes placed with it in a screen cage. If it contracts the malady, observers keep complete charts of its daily progress and relapses. Similar in nature to human malaria, but incapable of being transmitted to man, bird malaria provides a safe and enlightening means for studying the life history of the parasite.

SCREENED IN with the malarial mosquitoes that will bite it, the duck still doesn't seem to mind. The insects can be seen as black dots. A circular panel permits access to the cage when the knots are untied

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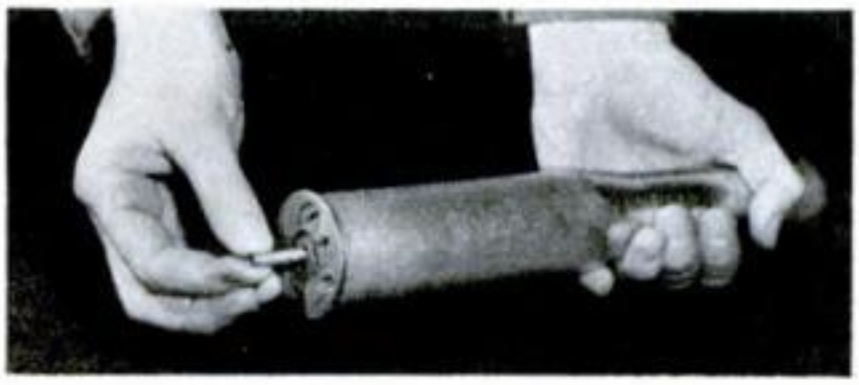
"JITTERGUN" TRAINS TANK MARKSMEN

BY PRACTICING with a 37-mm. gun mounted on a "wobble plate" that can be made to rear and buck like a rodeo bronco, students at the Army's Tank Gunnery School at Fort Knox, Ky., soon learn the trick of hitting a moving target 1,000 yards away while bouncing around inside a rough-riding tank. Mounted in the school's indoor range and operated by two men — one loading, the other aiming and firing — the big gun actually fires only .22 caliber bullets, which pass through the center of the dummy shell the loader rams into the breech. At the other end of the range, only 1,000 inches away, are the targets—models of men and tanks scaled down to appear 1,000 yards distant and moving at an apparent speed of 20 miles an hour. Operated electrically, the wobble plate is made to pitch and roll in simulation of a tank rolling over rough terrain at about 20 miles an hour. After only three days' training, students are said to be able to score an average of three hits out of every five shots.

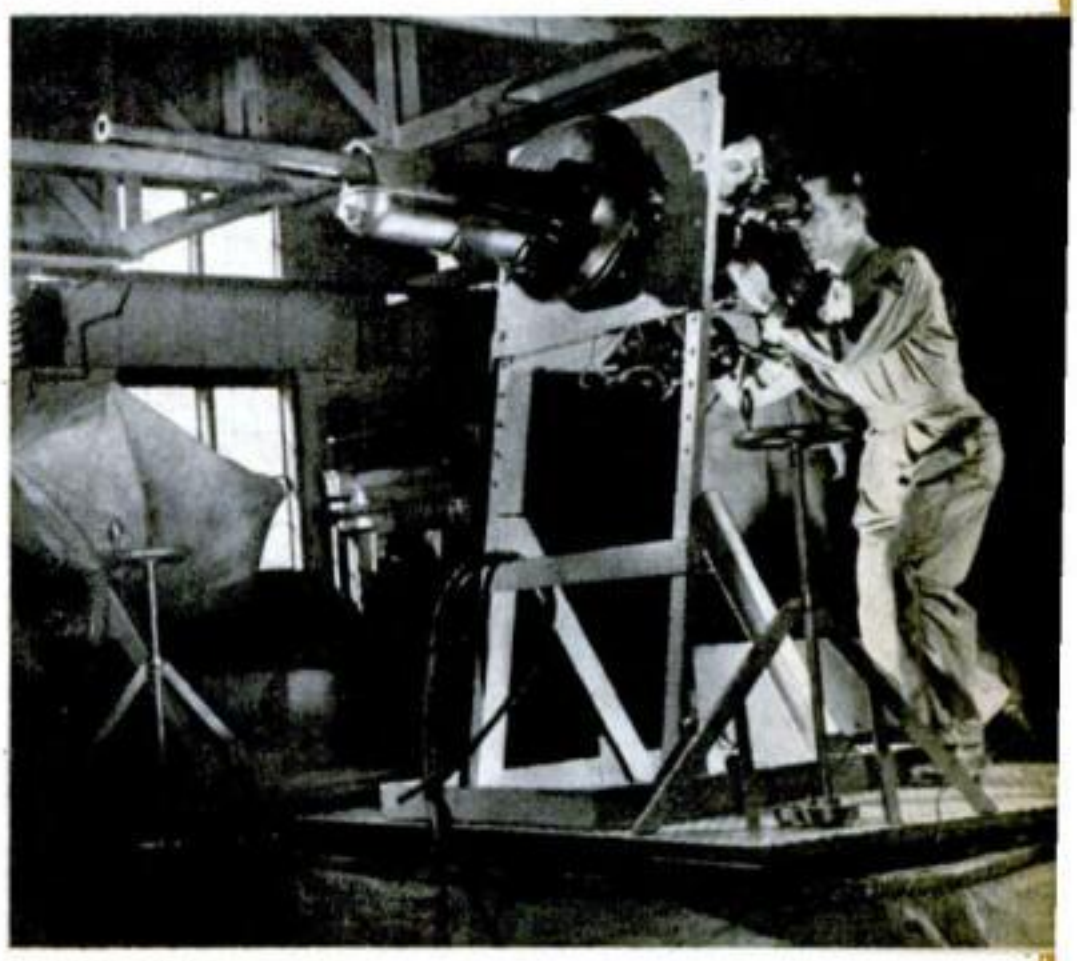
Photographs by ROBERT F. SMITH



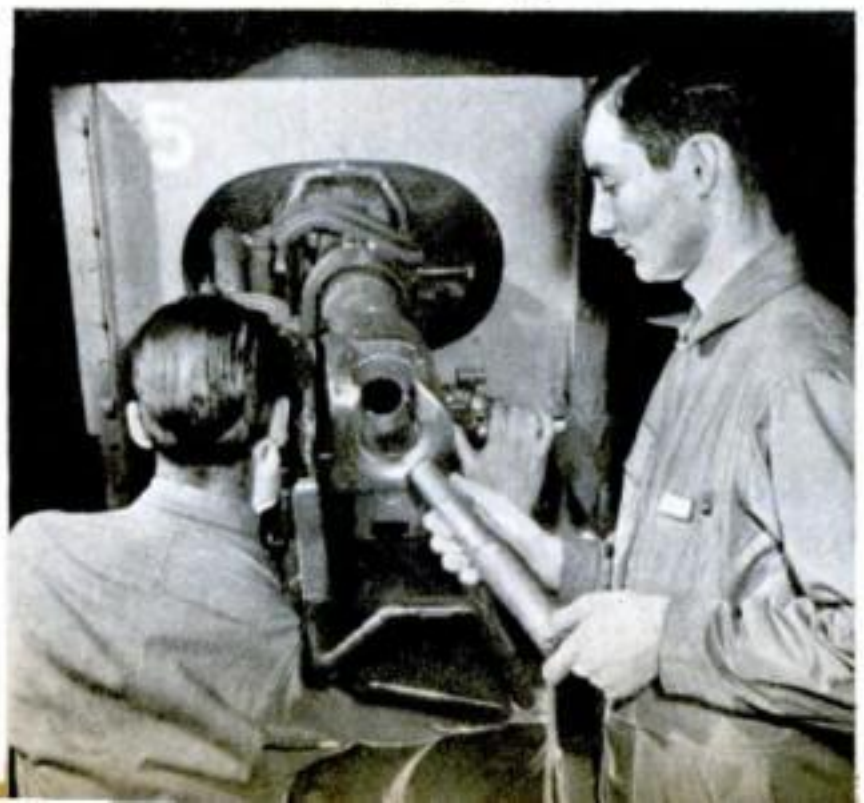
PITCHING AND TOSSING like a canoe in a high sea, this "wobble plate" at the Fort Knox Tank Gunnery School gives student gun crews the ride of their lives as they aim and load a 37-mm. gun, and then try to hit small moving targets at the other end of a 1,000-inch indoor range. Driven by an electric motor, the wobble plate reproduces all the jolts and jounces of a tank being driven full tilt over the roughest type of terrain



AMMUNITION consists of .22 caliber bullets that are shot through the center of the dummy 37-mm. shell rammed into the breach



AIMING and loading is done exactly as if the two-man crew were handling regulation ammunition and trying to pot real Axis armor



TARGETS. Looking like those found in a Coney Island shooting gallery, the targets are small models of men and tanks scaled down to appear 1,000 yards away, and made to move at an apparent speed of 20 miles an hour



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LIGHT BLUE



+DARK BLUE



+BLACK



+GREEN



This beautiful example of color printing is done with six screens, each with a stencil cut for the parts taking only one hue, as is indicated in the series of small photos at the top



+YELLOW



+RED

SPEEDY REPRODUCTION of designs or lettering in colors is simple and inexpensive with the silk-screen process, in which paint is forced through the mesh of a fabric stencil. By following the instructions on page 157, the home craftsman can make cards, posters, pennants, and decorated craftwork in quantity without laborious hand painting.

IT'S A SMALL WORLD to modern bombers, and you can follow their flights more readily on a sphere than on a flat map. A pedestal will transform any good-sized globe into a handsome accessory for the library or study. This one, designed in the Duncan Phyfe manner, is made of mahogany. The column is a lathe turning, and moldings on other parts can be made with cutters mounted in a drill press. (See page 144.)



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VULTEE VALIANT is a swift, rugged two-place basic trainer widely used by both Army and Navy for training combat pilots. These women workers at Vultee Field, Calif., are building some of the characteristics of today's hottest planes into the ship. Powered by a 450-hp. motor, the Valiant has a top speed of 182 m.p.h. and a 21,000-foot ceiling. Vultee recently completed its 10,000th trainer.

DRY YANKEE HUMOR is puzzling guards at a German base prison camp for Allied airmen, since American POW's there decided to adopt insignia to show their new status. The postcard below, sent by Capt. Robert H. Bishop, a bomber navigator now at the camp, brought the design at the right from the Walt Disney studios to Germany, via the Red Cross.





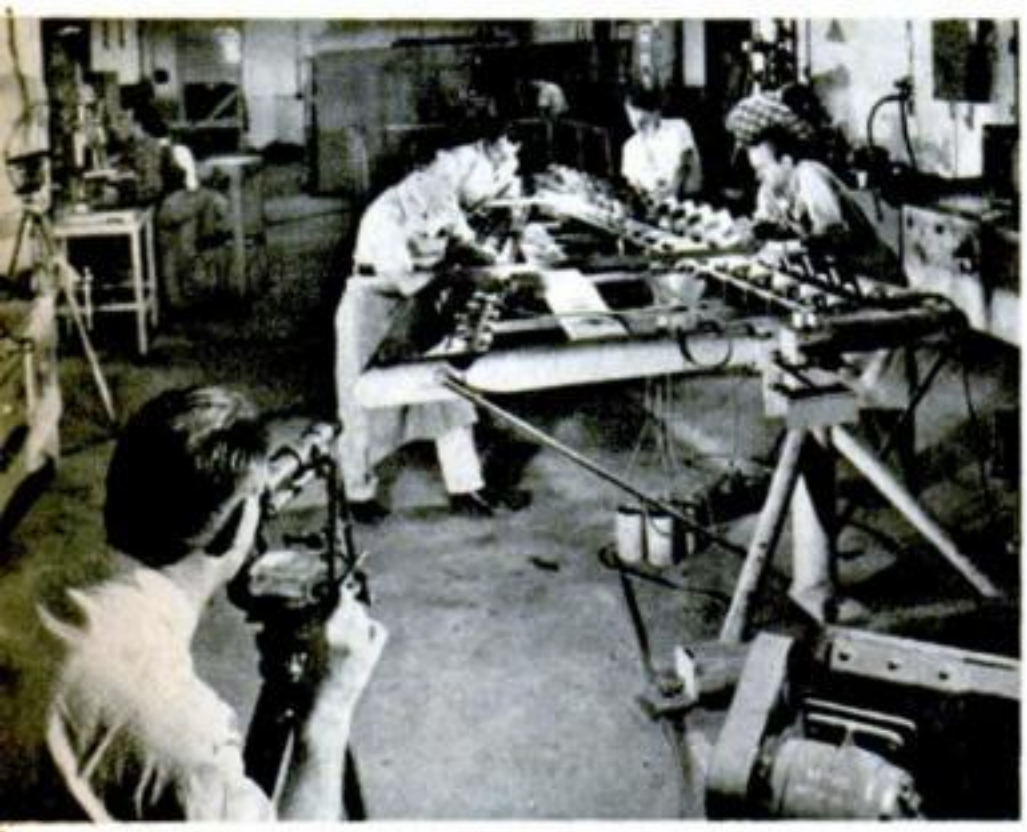
Novel emblem designed for U. S. prisoners of war in Germany by Walt Disney shows live fighting spirit

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Army Gliders Are Good



ARMY'S STANDARD troop and cargo-carrying glider is the CG-4A, seen here taking off behind its nylon towrope. Fifteen men, or an equivalent load in equipment, ammunition, and supplies, can ride it to a landing behind the enemy's lines. With its 84-foot wing span and 48-foot length, the CG-4A is not a simple craft to build, as the following photographs show



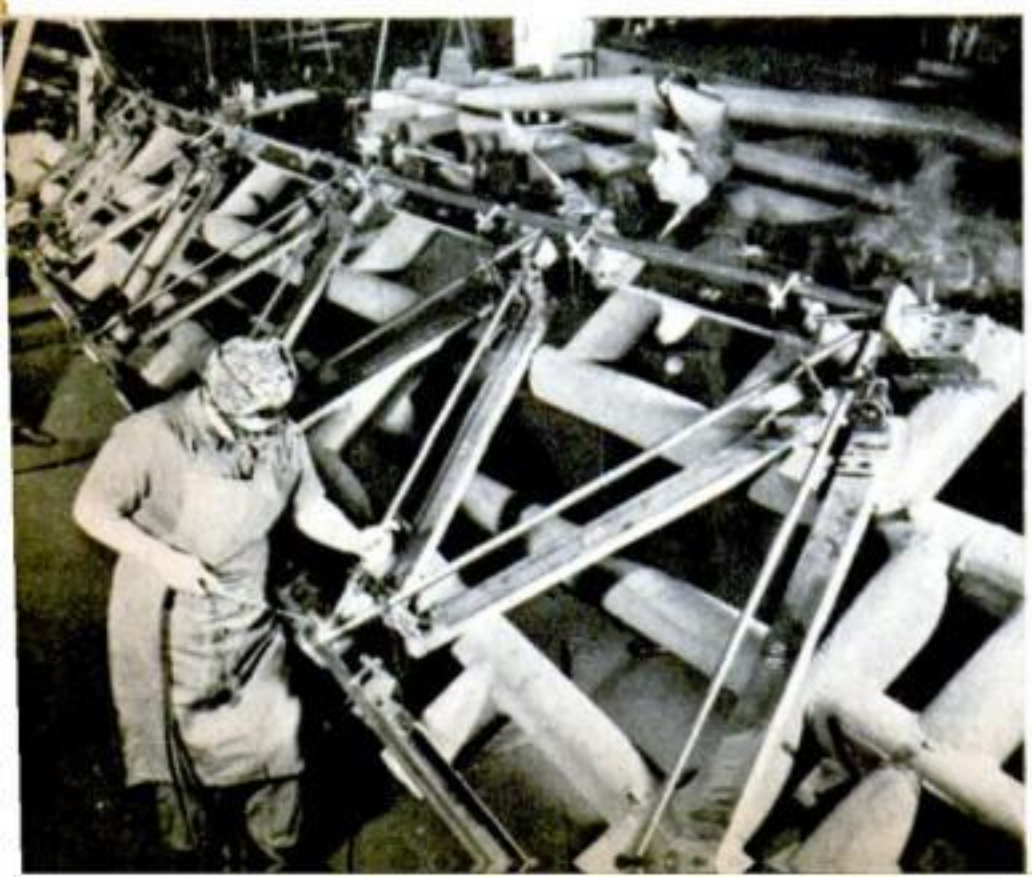
JIGS speed assembly of parts. Here a surveyor's transit is being used to check the accuracy of one of the jigs at the General Aircraft Corporation plant

MILITARY gliders owe much of their tactical value to the fact that they are expendable (P. S. M., Feb. '44, p. 94). But this doesn't mean that they are slapped together carelessly. For efficient performance, and for the safety of personnel, they must be built to the same high standards as our powered warplanes.

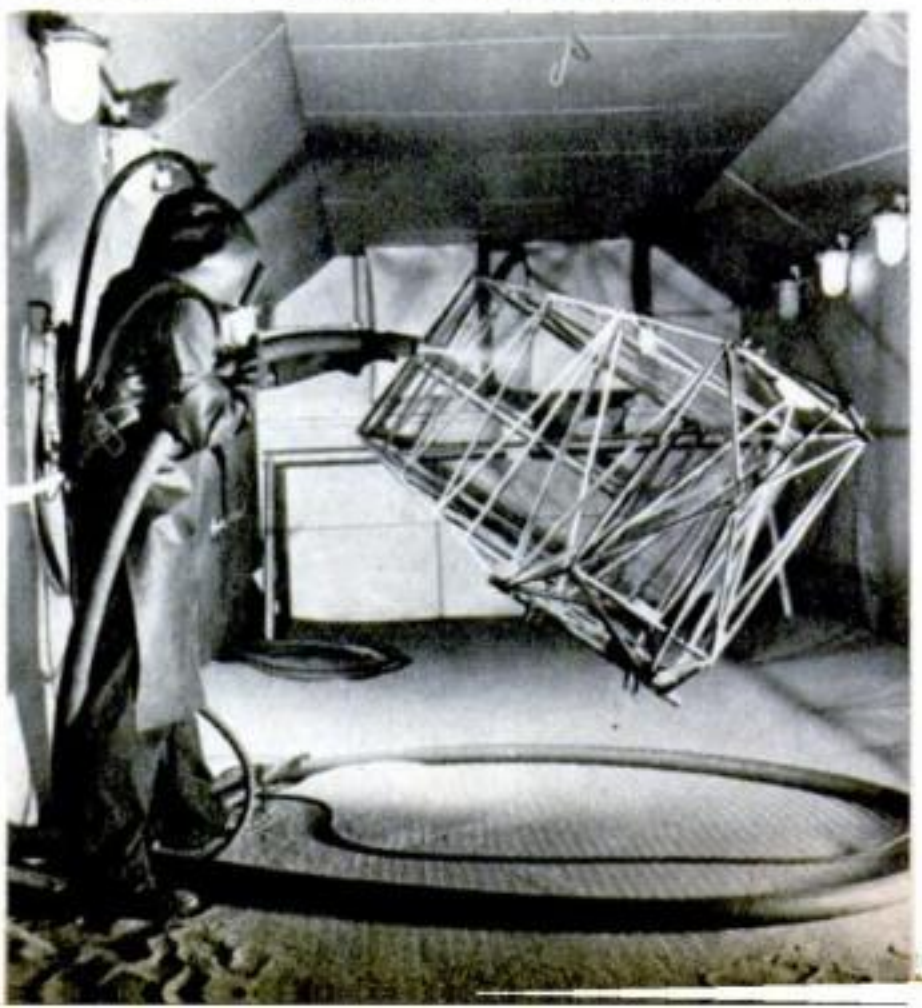
Except for the absence of motors, a big troop and cargo-carrying glider such as the U. S. Army's CG-4A is built much like an airplane. While it does not have to endure the stresses of powered flight, its lightweight structure must protect troops and supplies in crash landings.

The photographs on these pages, made at the Astoria, N. Y., plant of the General Aircraft Corporation, show various operations in the building of the CG-4A.

SIDE FRAMES for fuselages are formed by welding dural tubes held in a revolving, counterbalanced jig that gives workers quick, easy access to all parts



SANDBLASTING prepares finished framework for painting. The masked worker below is playing fine sand and compressed air on a tail section





LANDING GEAR parts are assembled by welding members together into clusters. Arc-welding gives rugged strength needed for crash landings



THE WINDSHIELD takes shape in another jig as the sheets of transparent plastic are installed. The blunt nose can be raised for loading and unloading



FABRIC is stitched and tied to fuselage and wing sections with heavy thread. One worker pushes the long needle through, while another sends it back



DOPING. Here two workers are covering stitches on a wing surface with tape and another is applying dope. Controlled temperature is necessary in doping



FAIRING STRIPS to cover the opening between wings and fuselage are shaped and drilled over a wooden form which is laminated to prevent warping

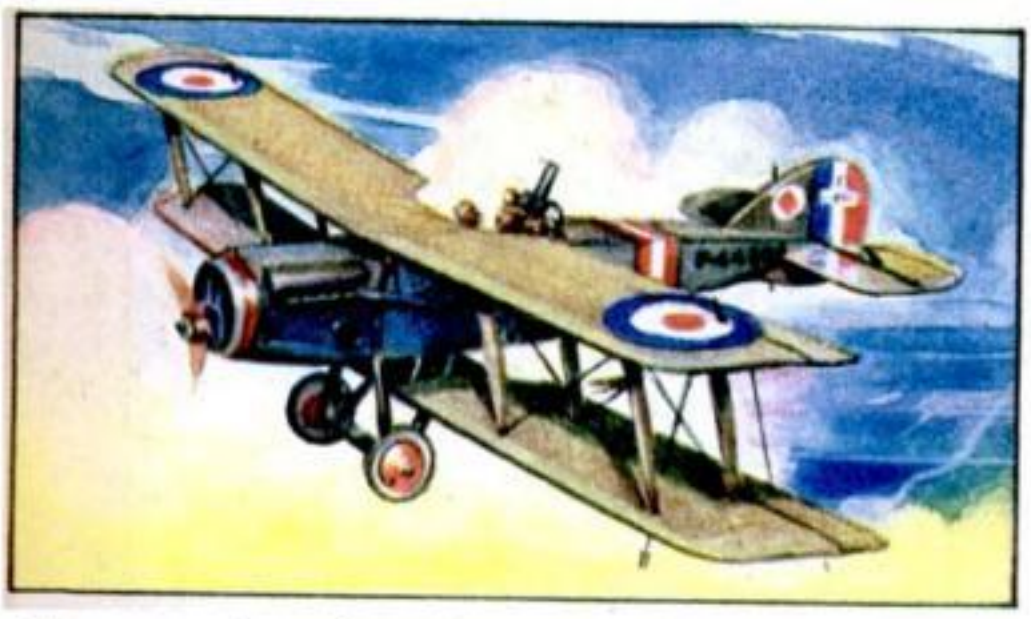
TOWROPE is fitted with a telephone cable through which the glider pilot can talk with the skipper of the towing plane. Cords bind the cable to towrope



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In 1912, Barnwell's 35-hp. Scout, with a speed of only 90 m.p.h., set the pattern for modern plane efficiency



Five years later his two-seater Brisfit was outfighting the fastest German single-seater planes of World War I



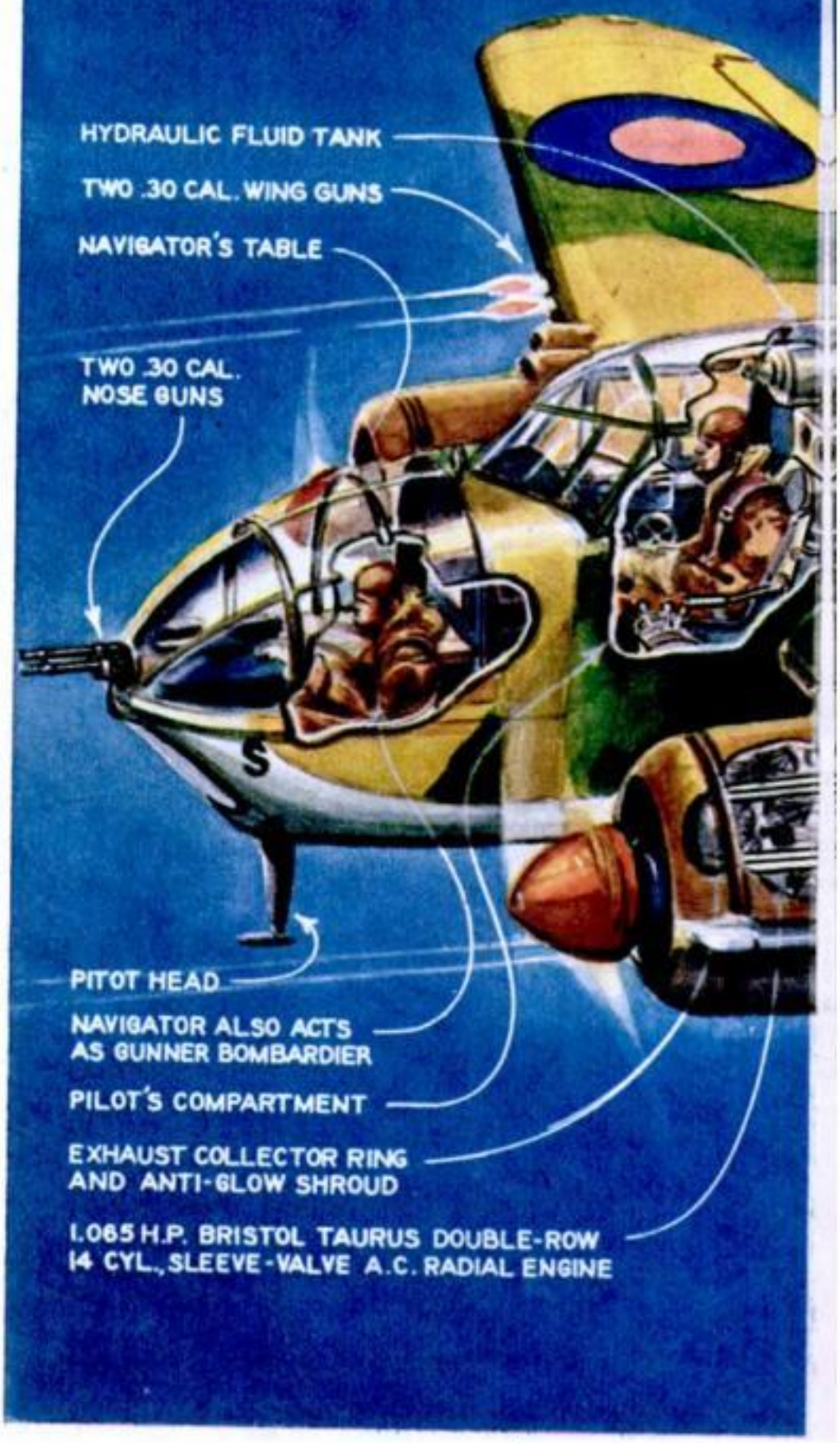
A midwing monoplane with retractable landing gear was conceived by the designer as far back as 20 years ago



The Bristol Bulldog, of which Barnwell was a codesigner, became the RAF's standard single-seater fighter in 1930

WHY THE NAZIS

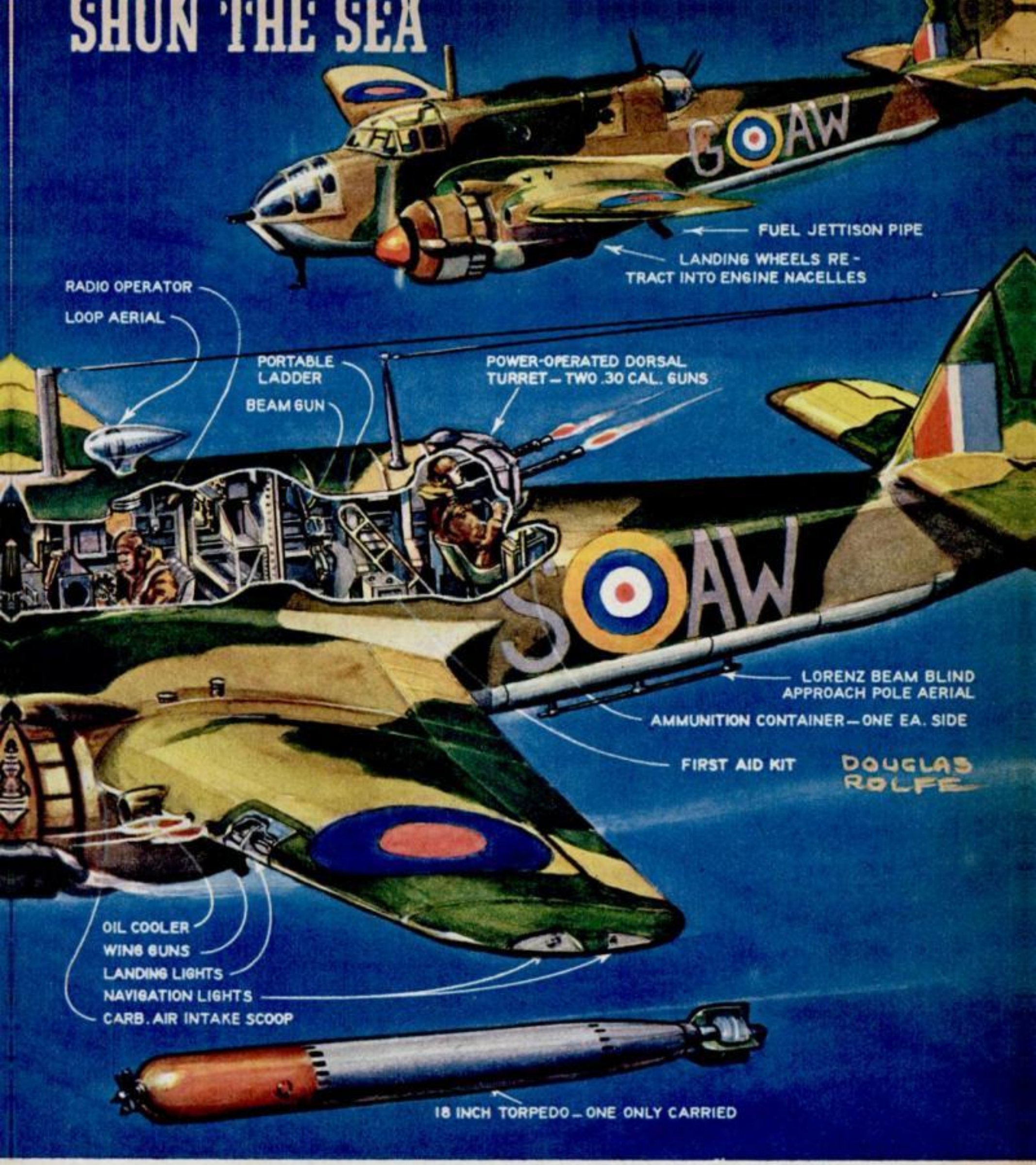
Britain's Bristol Beaufort Torpedo Plane



SHORTLY after it was organized in 1910, the Bristol Aeroplane Company engaged as its head designer the late Captain Frank Barnwell who, for the next 25 years, was the mainspring of a company that has turned out some of the finest fighting planes Britain has ever put into the sky. Barnwell's very first design—a tiny 35-hp. plane that compares favorably with modern planes of similar power—completely revolu-

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SHUN THE SEA



tionized the concept of airplane efficiency of that day. In 1917 he designed the Brisfit, a fast and highly maneuverable two-seater that is said to have been the best fighter in World War I and set an all-time record by remaining in the service of the RAF for nearly 10 years after the close of hostilities. In 1922, Barnwell brought out a plane that was 20 years ahead of its time—an experimental midwing monoplane with a completely encowled radial engine and retractable landing gear. Thirteen years later he produced the Blenheim, the fastest two-engined bomber in the RAF and the prototype for two other now famous ships: the Beaufort, Britain's standard land-based torpedo plane, and the Beaufighter, which, with its four cannon and six machine guns, is the world's most heavily armed fighter. Both planes have top speeds of over 300 m.p.h. The Beaufort is being used in large numbers by Britain's Coastal Command.

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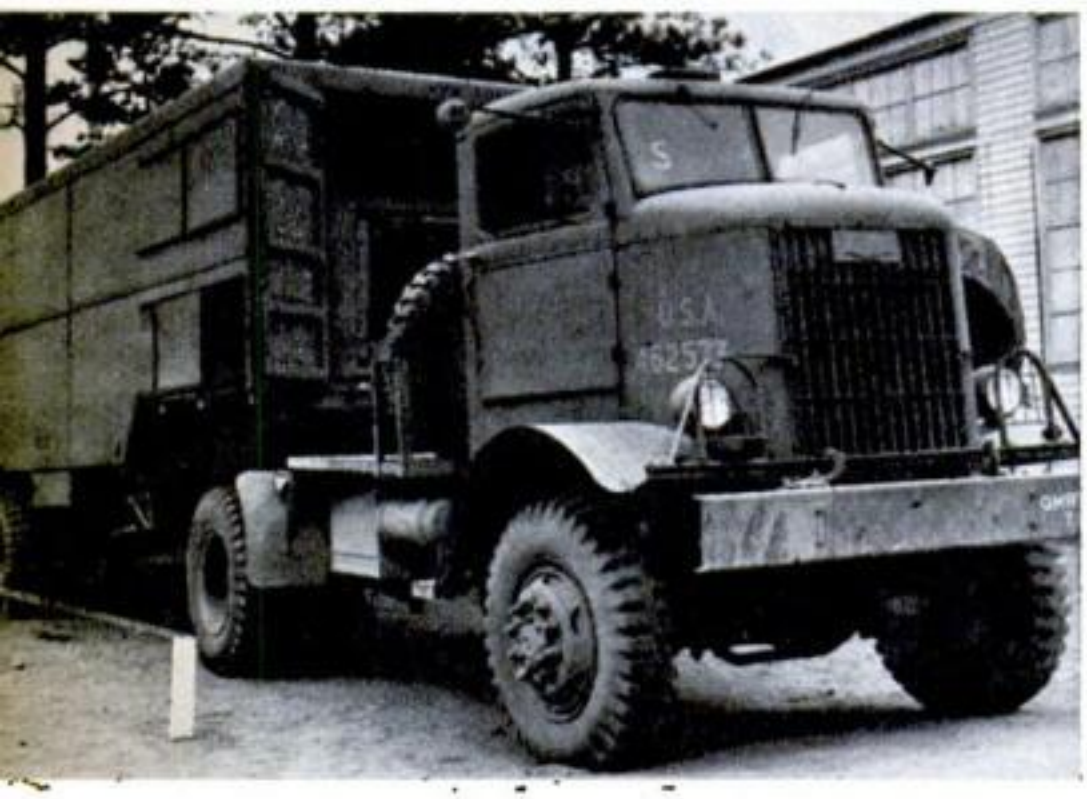


The Army

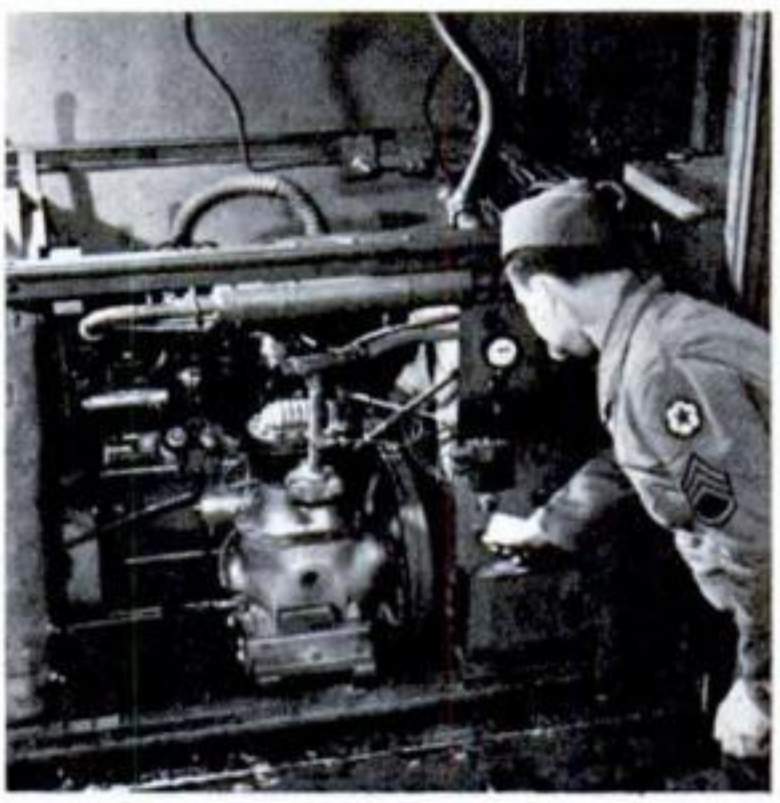
YANKEE INGENUITY GIVES

TRIGGER-FINGERED mittens neatly solve the arctic soldier's problem of how to keep his hands warm and yet be able to use his index finger for pulling a gun's trigger. Made of poplin, which is more flexible than leather in cold weather, the trigger-finger sheath folds down on the back of the glove after the soldier has finished shooting and has withdrawn his finger to reinsert it in the warmer cowhide-covered part of the mitten.

ROLLING REFRIGERATORS that can follow on the heels of fast-advancing troops are being used by the Army to keep soldiers on far-flung fronts well supplied with fresh foods. Each of these tractor-trailer units has a five-ton capacity and carries a 2½-ton gas engine that is thermostatically controlled and capable of producing temperatures from 35 degrees F., for perishable foods, to 10 degrees for frozen foods. Insulation in the 140-cubic-foot trailer consists of a six-inch cork flooring and a six-inch layer of glass wool at the top and sides. After each trip, the unit is defrosted.

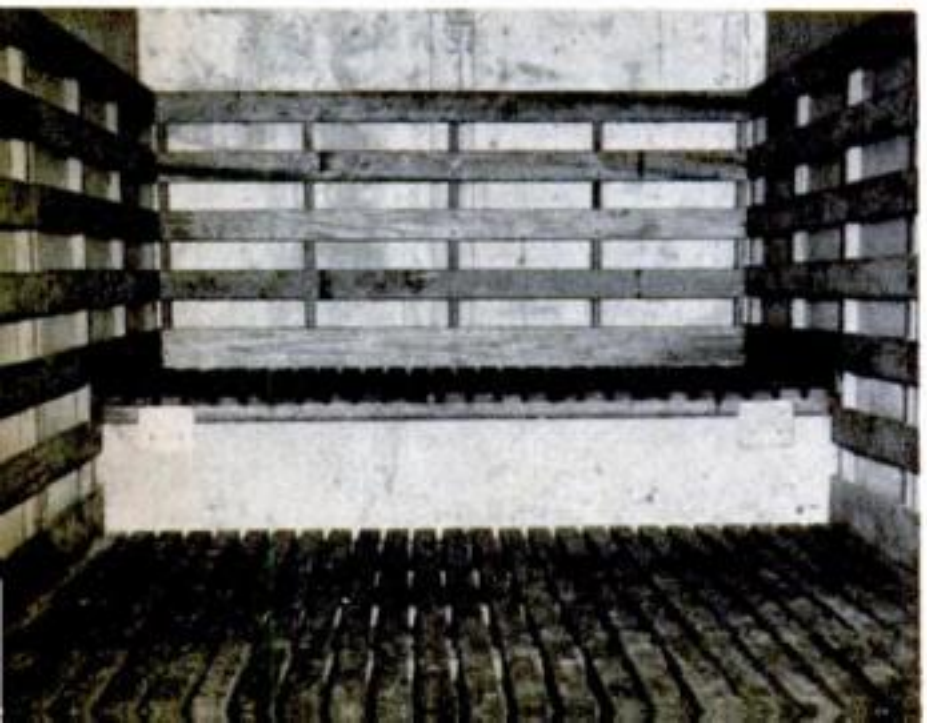


FIVE-TON LOADS of perishable or frozen foods can be carried in each tractor-trailer, three of which can supply an entire division. Enemy pilots are willing to sacrifice two planes to blast one of these refrigerators

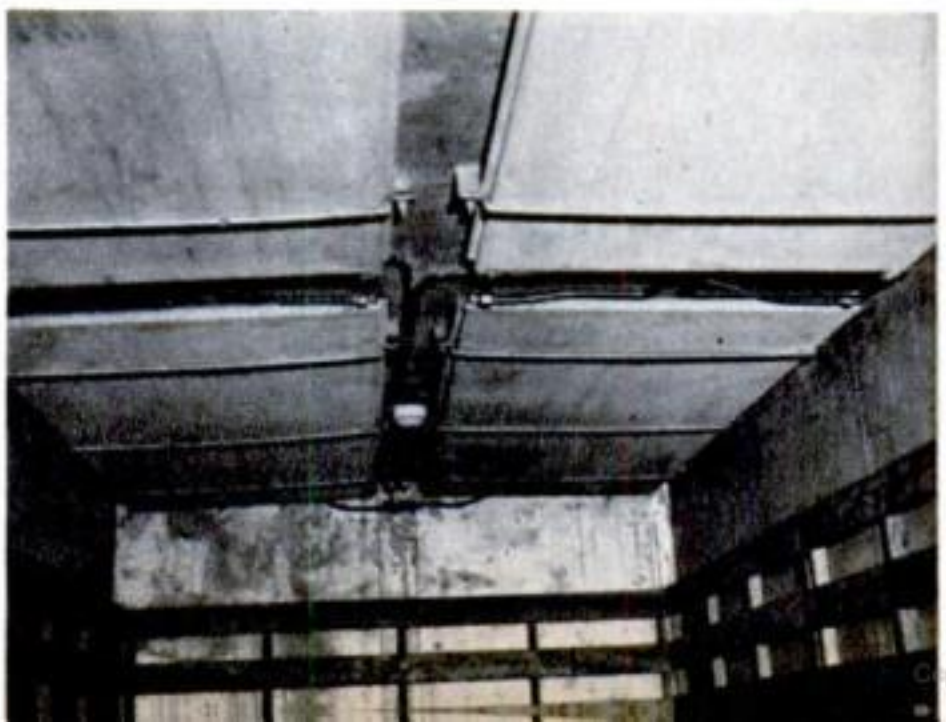


COOLING UNIT is a 2½-ton gas engine that uses Freon to produce temperatures from 35 to 10 degrees F. Under thermostatic control, engine starts and stops automatically

WALLS AND FLOOR of trailer are lined with protective wooden slats. Compartment on floor is for the storage of fragile articles



CHILLING is done by means of cold-plate evaporators fixed to the ceiling on removable racks. Brine in evaporators aids in maintaining low temperatures



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Finds a Better Way

OUR SOLDIERS THE VERY BEST EQUIPMENT FOR EVERY JOB



IN THE BAG now being issued by the Army is the answer to the soldier's prayer for a duffel container that has sufficient capacity, is easy to carry, and offers adequate protection against rain and moisture. In addition to these features, the new kit provides a metal U whose arms can be slipped through the bag's eyelets (shown below at left) and then fastened with a lock. Made of a camouflage-green duck, the bag has been specially treated to protect its contents against mildew and is capable of withstanding a lot of rough handling. One of the features for which soldiers are especially grateful is the attachable web sling which a man can throw over his shoulder and thus comfortably carry a heavy load. For a handle, the kit has a sewn sling.



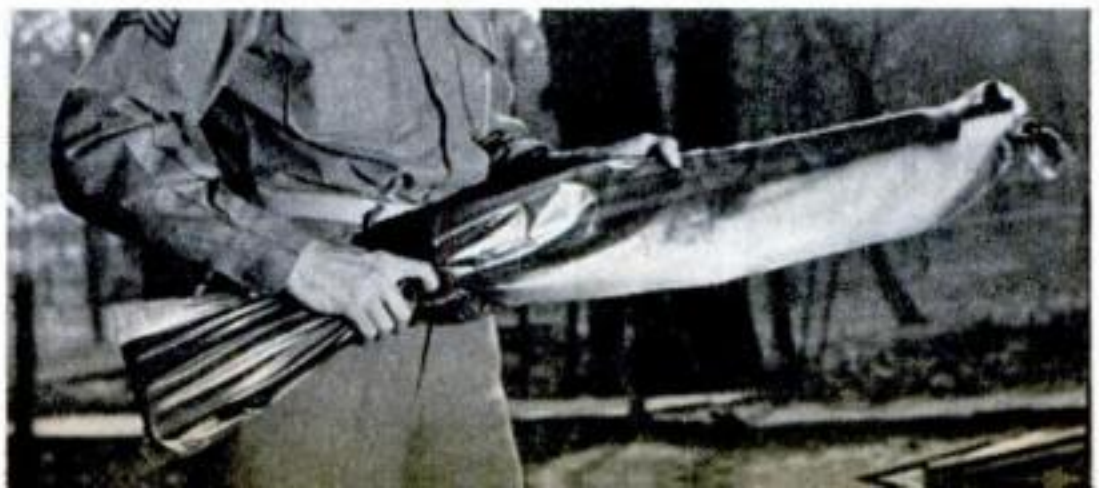


MANY LAYERS of light clothing, instead of only one or two of heavy woolens and furs, have been found to be the best way to keep our soldiers warm in the Arctic. The secret lies in the insulating air pockets formed between the layers. Starting with light woolen underwear, a soldier dons light alpaca and covers that with GI poplin or herringbone twill. As the thermometer drops, he merely adds more under and outer clothing.

A PACK BOARD of plywood helps soldiers to carry cumbersome equipment into areas where vehicles cannot penetrate. Cord is used to fasten loads to the board, which is fitted with adjustable shoulder straps. Canvas extending between the board's curved edges cushions the load on a soldier's back. Like the other items on these pages, this carrier was developed by the Army Quartermaster Board at Camp Lee, Va.



WATERPROOF SACKS of thin rubberoid plastic are protecting the rifles of our soldiers when they have to splash ashore from landing barges. The sack fits loosely over a rifle and allows a soldier to pull the trigger if things suddenly get hot and he hasn't time to remove the gun's covering.



Lamps

When "the Lights Go on

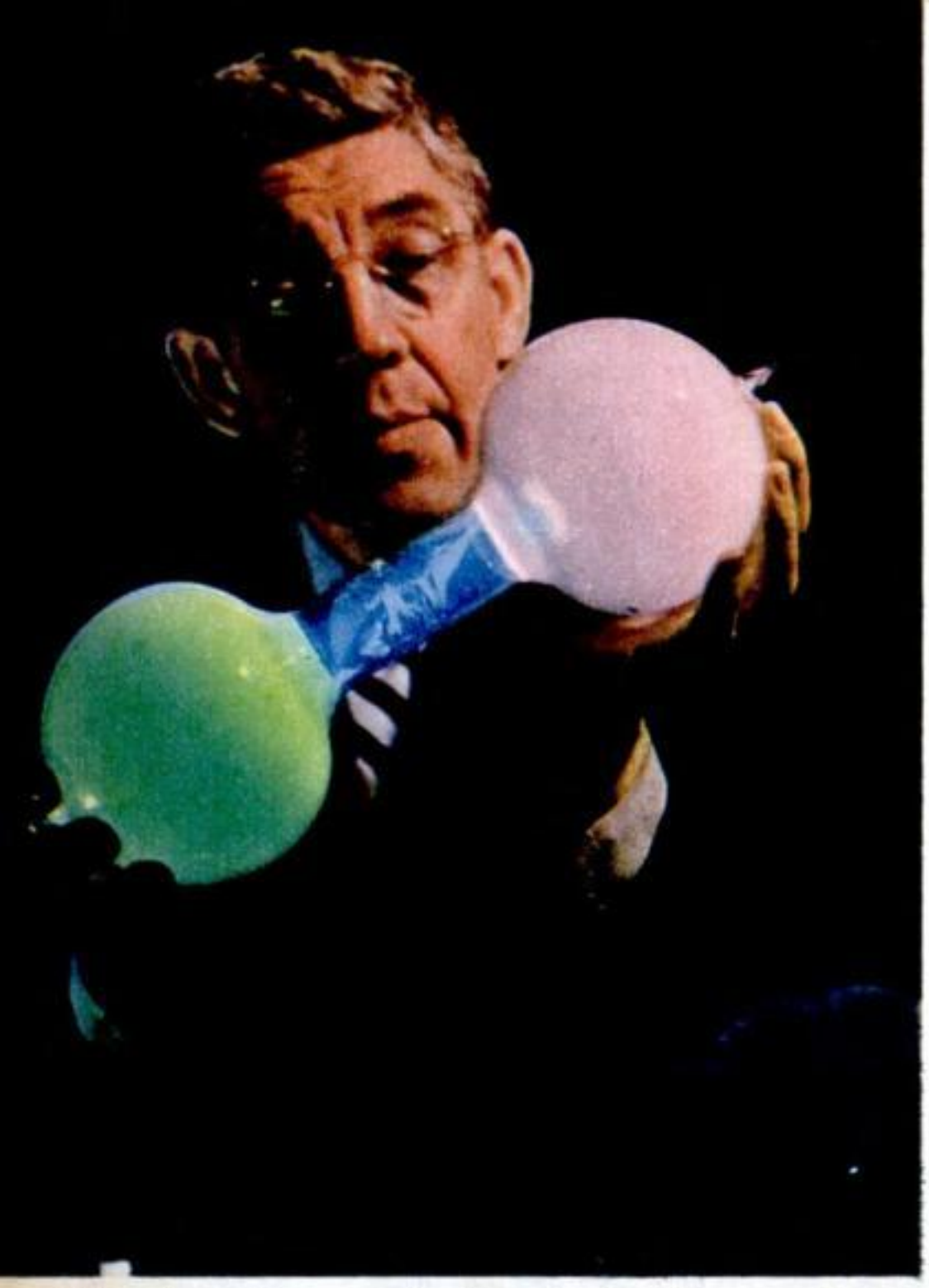
By

ALDEN P. ARMAGNAC

Photos by ROBERT F. SMITH

IMAGINE lamps that light by radio power, that stay on when they are turned off, and that kill germs in the home. Will future dwellings contain such scientific wonders? In experimental form, these and other appliances as remarkable have already been demonstrated by Samuel G. Hibben, director of applied lighting at the Westinghouse Lamp Division, Bloomfield, N. J.

Just because fluorescent lamps commonly have a tubular shape is no reason for having to make them that way, he points out. He exhibits laboratory samples shaped like globes or dumbbells. Special glasses or ash trays filled with a metallic vapor also are made to glow from radio power. Besides white and amber lamps for reading, luminous spheres of any color will suit a homeowner's fancy for decoration.

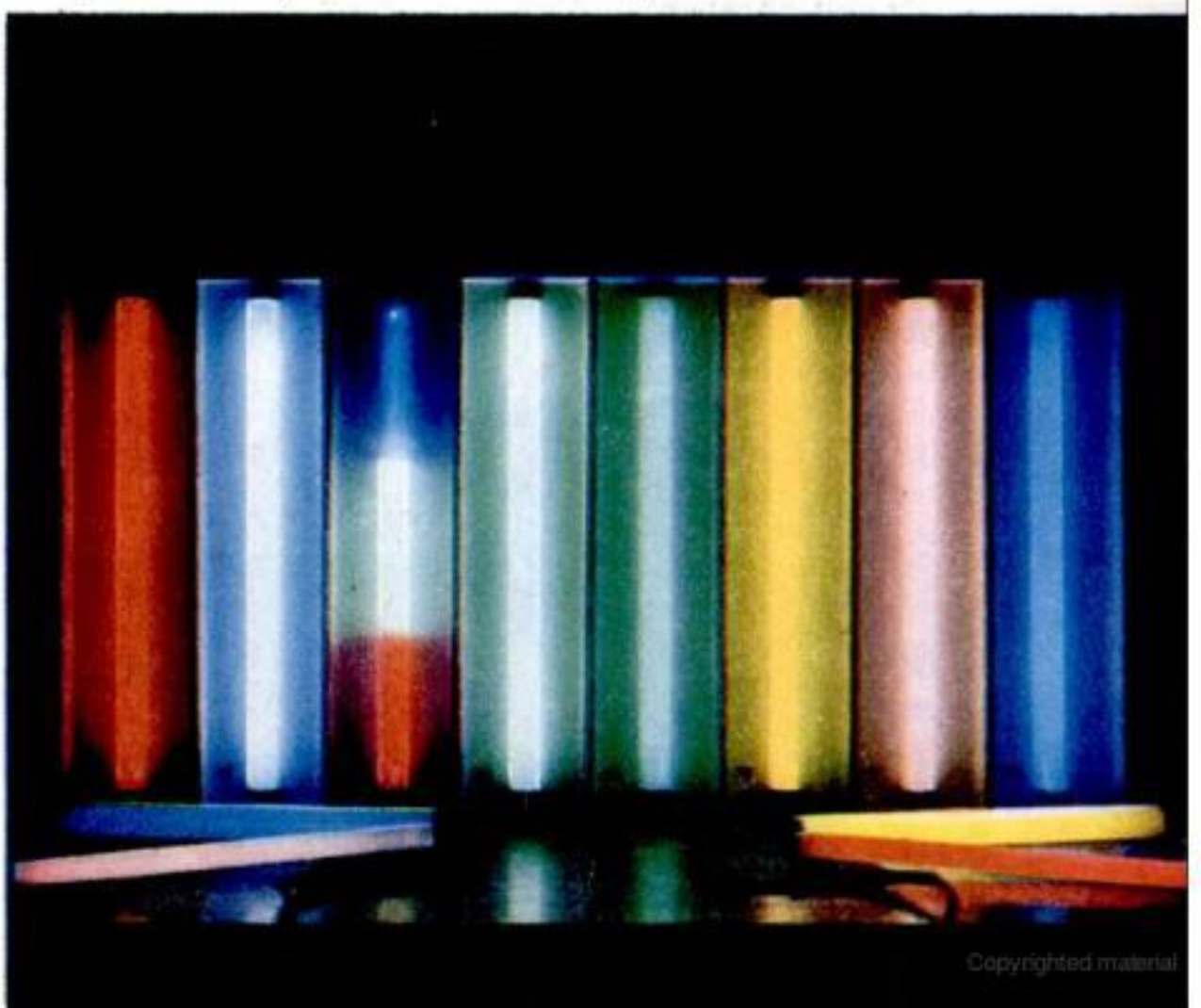


Although usually seen in the form of tubes, fluorescent lamps may be manufactured in many shapes, and in a wide variety of colors. This dumbbell-shaped lamp being demonstrated by Samuel G. Hibben, a Westinghouse lighting expert, is made to glow with green, blue, and pink light by bombarding its luminescent coating with high-frequency radio energy

This portable diathermy instrument, of the type found in doctors' offices, is lighting the unconnected lamps in the photograph at the right. More powerful instruments are employed to light lamps that are far removed



A group of fluorescent lamps of modern designs and colors. Those standing in the background are being lit by current carried through conventional wiring. The smaller ones in the foreground, however, are being lit by radio power emanating from the pads of the diathermy instrument at left



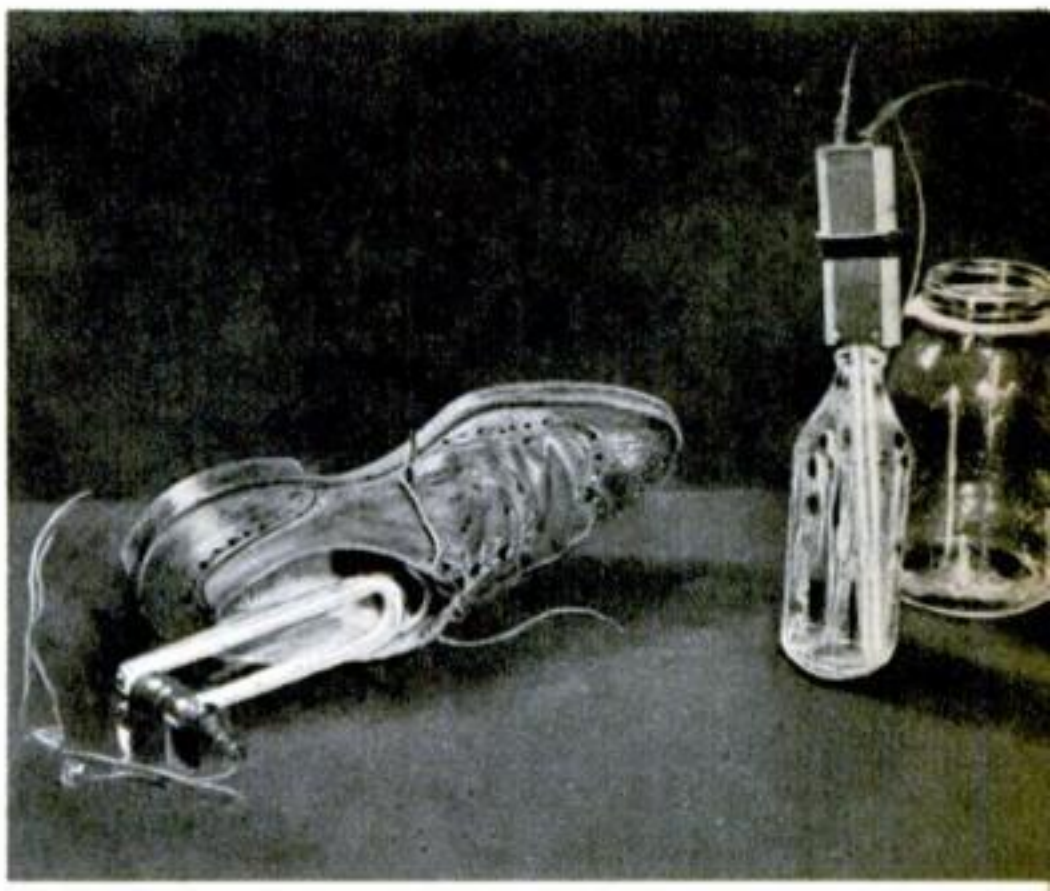
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of Tomorrow

Again" After the War, They Will Be Lit by the Magic of Radio

Wiring? That little matter may be ignored, as far as external appearance goes. By way of trial, Hibben suspended a small diathermy machine, which radiates ultrashort radio waves, from the ceiling of his cellar. When he filled a fruit bowl on his dining-room table with fluorescent globes, they lit up to make a rainbow-hued centerpiece. Permanently installed in walls and floors, similar radio equipment could obviate need for certain special light fixtures and outlets, permitting portable lamps to be moved about wherever wanted.

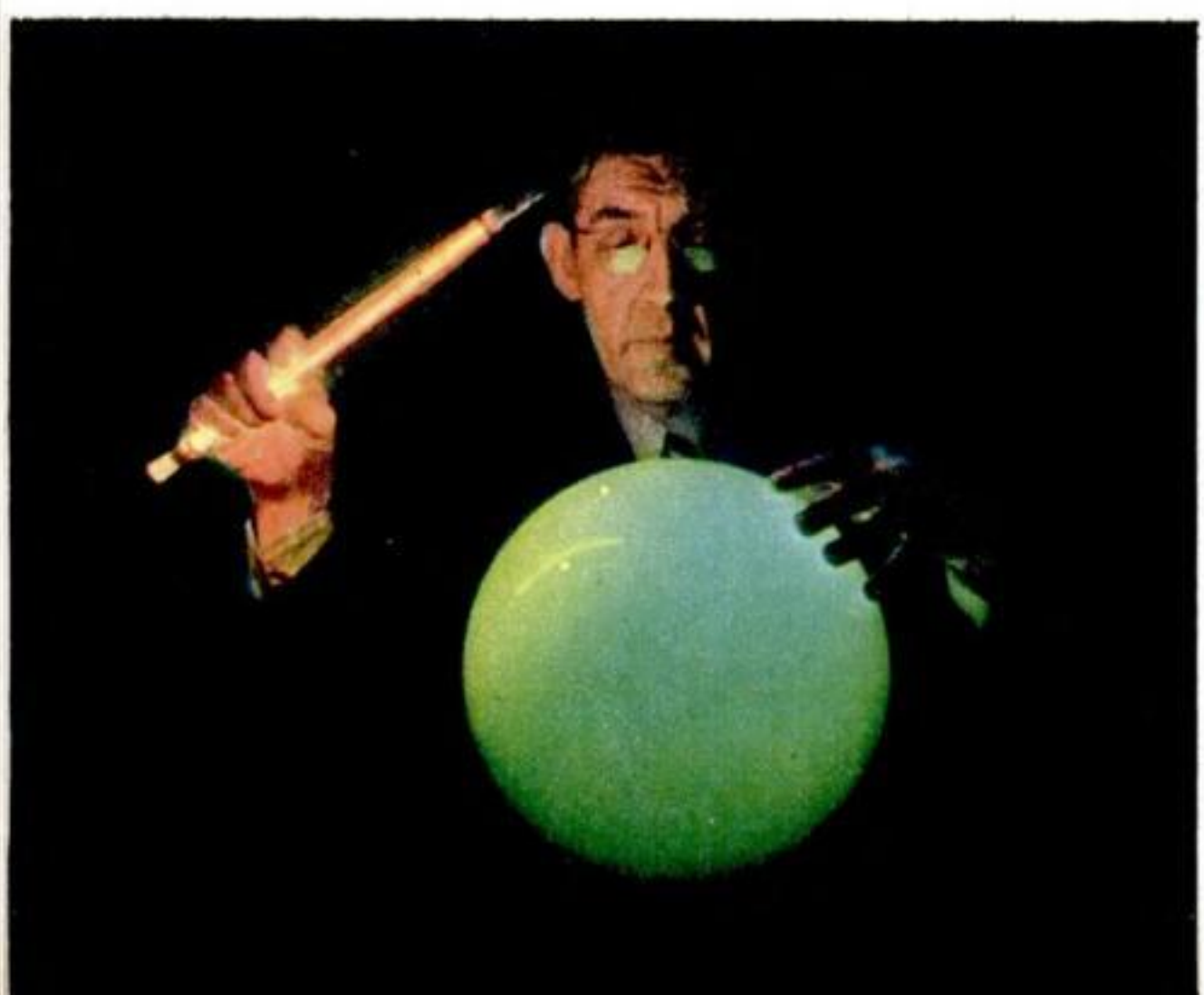
Midget versions of bactericidal lamps used in hospitals, which kill germs with ultraviolet rays, could serve a variety of household purposes. One tiny model would keep baby's bottles germ-free. Also applicable in preserving, it would offer assurance against spoiled batches. A "shoe-tree" lamp of similar type is said to keep shoes free from the organisms of athlete's foot.



Midget versions of the germ-killing ultraviolet lamps used in hospitals will fill such household needs as sterilizing baby's milk bottles and the jars in which foods are preserved. A new "shoe-tree" germicidal lamp, seen in use at the left, is said to keep footwear free of organisms that cause "athlete's foot"

Certain minerals become brilliantly luminous under black light—ultraviolet rays from a lamp screened to shut off visible radiance—and night prospectors apply the fact to search for desirable ores (P.S.M., Dec., '39, p. 104). For home decoration, the minerals may be pulverized and made into enamel for walls, which glow in handsome hues when illuminated by concealed black-light lamps.

An amusing bit of showmanship demonstrates the "lamp that won't go out." While Hibben discusses other laboratory developments, he keeps an innocent-looking little bulb burning in a standard screw socket. At length, he calls attention to it, and takes out the bulb. To the observer's astonishment, it continues to glow as it lies in the palm of his hand. Its secret is a phosphorescent coating, which gives off light for several hours after being activated by the bulb-shaped vapor lamp. In one practical application suggested by the trick, lights of this design could mark fire exits of theaters and other public places, guiding occupants to safety if normal current failed.



Looking like a modern sorcerer, Hibben examines two lamps of the type that may light our homes of tomorrow. Both lamps are being illuminated by radio power, whose source in the floor and walls of a room permits the lamps to be moved without concern for a trailing electric cord over which people may trip

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PRISONER! Pvt. L. L. Lear, one of the South African Medical Corps' snake catchers, spots a deadly puff adder and, at right, has it in the bag. Its venom will save lives

Army Snake Hunters

SOUTH AFRICAN SOLDIERS SNARE POISONOUS REPTILES FOR VENOM

ODDEST army group among Allied forces, a South African Medical Corps detachment catches venomous snakes and extracts their poison for snakebite serum. Two of South Africa's deadliest reptiles are most sought, the puff adder for its virulent blood poison and the yellow cobra, which produces a nerve poison. Twice a month the snakes, carefully tended on a "farm" after capture, are "milked" of their venom by massaging the tops of their heads while the fangs are held over the edge of a glass. The thin, clear liquid is dried and sent to the South African Medical Institute. There selected horses are injected with successively larger doses of the two venoms to make a serum which is saving soldiers' lives on fronts all over the word. The three men insist that if you are gentle, snakes are easy and safe to handle.



"MILKING." A head massage persuades an adder to eject its poison into a glass. Dried venom from 70 puff adders (right) or 45 cobras (left) would fill a cigarette



THREE MEN comprise the South African anti-snakebite corps—left to right: Private Lear, Corp. F. Walsey (in charge), and Corp. M. J. Clemence. The snakes are a black mamba (left) and a python

At the bottom of a clear Florida lake, a Navy motion-picture cameraman films a diver at work

Diver Stars in Navy Film

TO TRAIN student divers in the tricks of their hazardous trade, a Navy motion-picture photographer recently took his camera to the bottom of the lake at Silver Springs, Fla., and photographed an expert diver as he went through a routine of proper diving techniques. "Shooting" was in the best Hollywood style, with a script girl and production crew splashing around on the surface in bathing suits. When working below, the director and cameraman used small diving masks.

OFFICIAL U. S. NAVY PHOTOGRAPHS





Wearing a diving mask and kicking his feet to stay in position, the cameraman grinds away as the diver demonstrates the best techniques of underwater work. Film was made for the training of student divers

Enter the hero—from the end of a ladder. These unusual pictures were shot by cameramen of the Navy Photographic Science Laboratory

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DANCING down a 45-foot plaster mountain in a scene for a forthcoming movie, Rita Hayworth posed a problem for Columbia Pictures cameramen. They solved it by using a 26-foot camera boom rolling on a 150-foot track, which made it easy to shift quickly from long shots to close-ups.

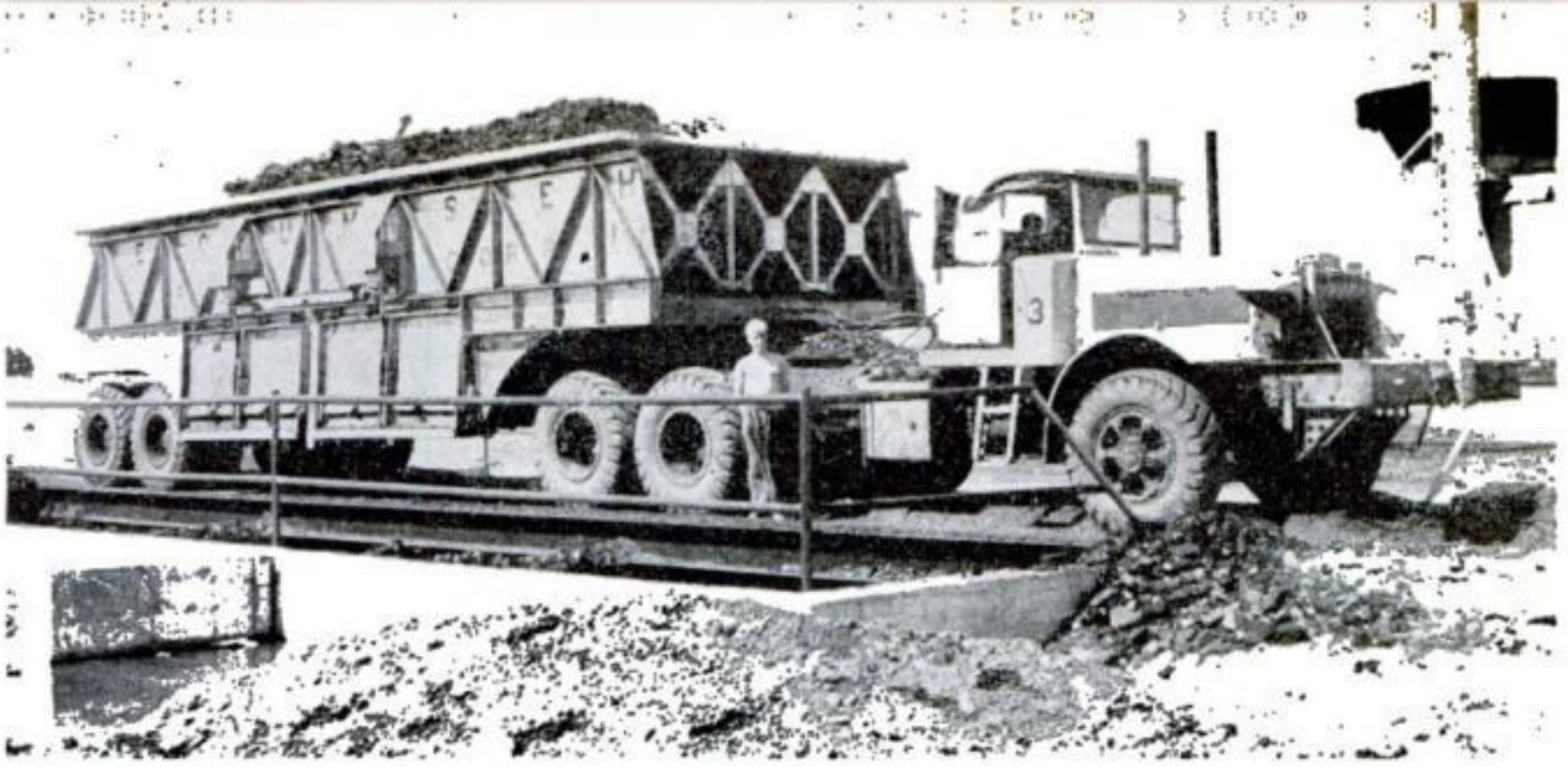
LANC'S LIFEBOAT is the radio-equipped rubber dinghy below, which is automatically released and inflated if the big British Lancaster bomber gets ditched in the Channel. Each flyer wears a whistle to help the others find him in the water at night.





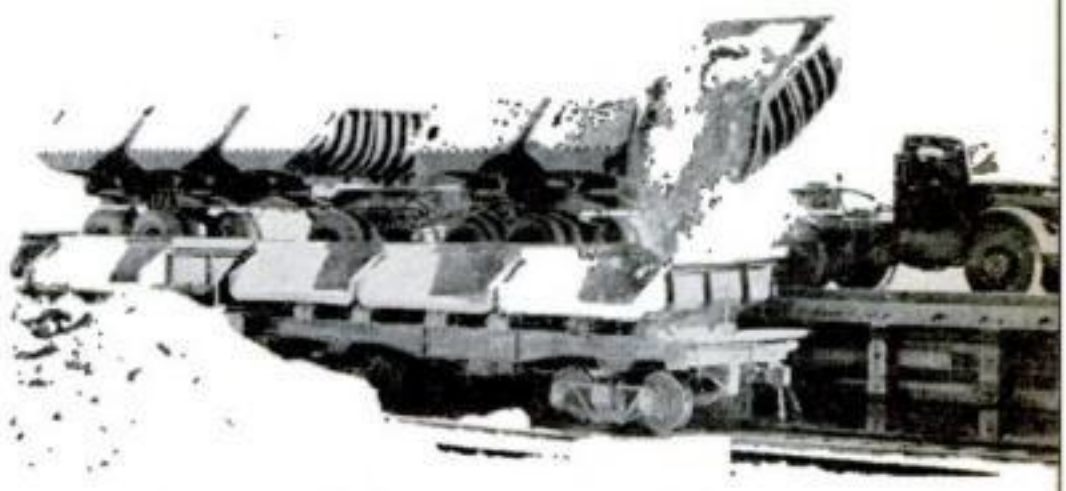
LIBERATION is promised the enslaved peoples of Europe in the design of a shoulder patch adopted for personnel of U. S. Army Headquarters, European Theater of Operations. A "V" of thunderbolts shatters a chain in the oval badge, which is about three inches long and two inches wide.

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Eighteen tires on this trailer-tractor combination bear the weight of 50 tons of coal, mined from an open pit in southern Indiana. A shovel bringing up six tons at each scoop was used to fill the body

SUPER-TRUCKS that carry raw materials away from mines and quarries have proved superior to rail cars, especially on short hauls. Climbing steep grades and requiring no track extension to keep up with forward-moving shovels, such many-tired giants transported 300,000,000 tons of coal and metallic ore in 1943. Report on the operation of a single 30-ton truck tells the story: In a three-shift, 24-hour day it can carry 3,000 tons. Fleets of these Mack-International trucks working with Diesel and electric shovels can open new mines within a few days. At open-pit mines they are unequalled, the makers say.



Total haul of this Mack tractor is 80 tons—each set of three side-dumping skip bodies holding 40 tons of stone



SHOCK FROM IMMERSION is greatly reduced when flyers downed in icy waters wear waterproof overalls. Exposure suits like the one seen at left, developed for U. S. and Canadian air-sea forces, will keep men warm for hours after they climb from the sea onto life rafts.

GRENADE NO. 69 gives the enemy no time to escape or to hurl it back. A concussion weapon, which explodes immediately upon landing, it is made in seven parts of Durez plastic, and was developed by Joseph Stokes Rubber Co., Ltd., of Canada. Use of plastic makes the grenade resistant to weather, water, and mud.





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One Tanker Must Get Through!

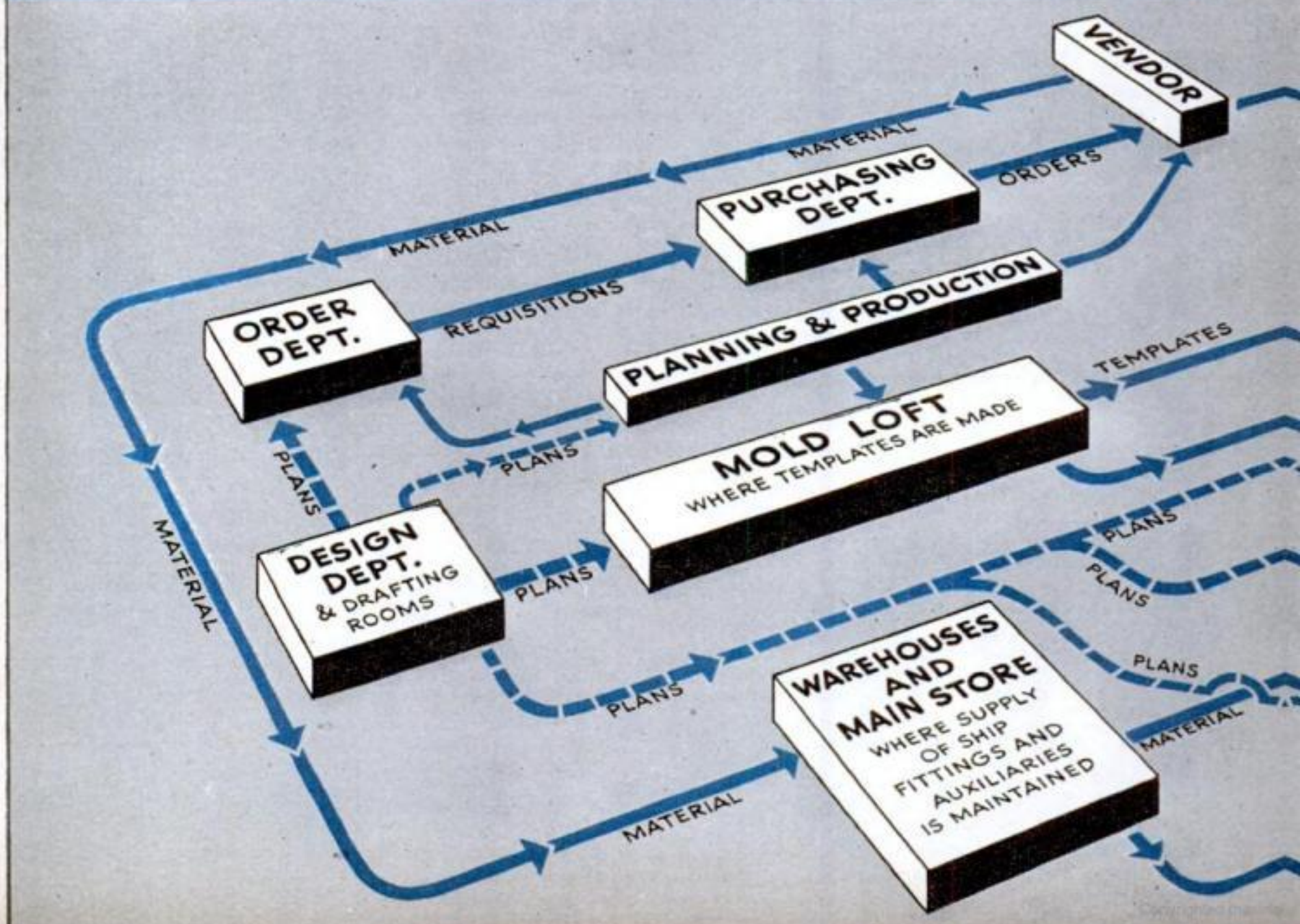






6,750,000 GAL. HIGH-OCTANE GAS = TWO HEAVY RAIDS

FLOW CHART: FROM PLANS AND STEEL TO FINISHED SHIP



FLOATING FUEL TANKS KEEP THE BOMBERS FLYING

HOW SHIPYARDS TURN OUT THE VESSELS THAT FEED OUR AIR ARMADAS

By JACK O'BRINE

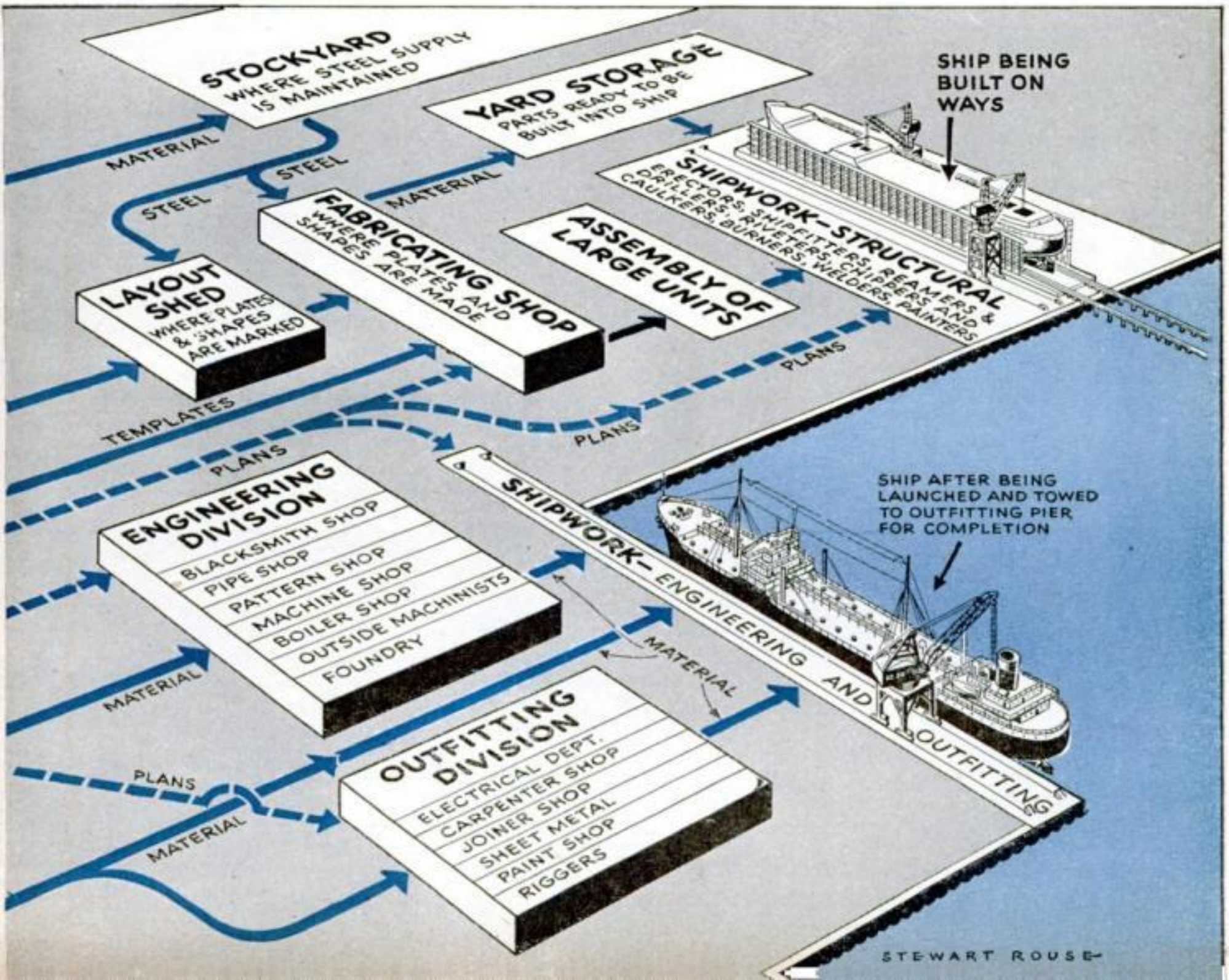
WITH men and steel and imagination, U. S. shipbuilders fight to overcome our No. 1 war handicap—two wide oceans to cross. They've already given us a merchant fleet nearly three times its prewar size. But that's not big enough. They must build faster and faster, lest front lines overseas falter and fail for want of food, fuel, and reinforcements.

In the surging drama of our shipbuilding program, all vessels assume importance. Each one has her role in literally carrying the battle to the Axis. Every new ship, from the great gray troop carrier to the lowliest seagoing craft, adds to our combat strength. We dare not underestimate the contribution of a single one. But a thick slice of glory must go to the tanker—that world-girdling fuel packer—without which our thundering air armadas would sputter and die.

When our Flying Fortresses and Liberators zoom off on one of their devastating 1,000-plane raids on the Reich, they lug enough gasoline to keep the average American motor car running for 1,000 years. Each plane has to carry around 3,000 gallons to get to the target and back to Britain. But—you've guessed it! Some unsung tanker has braved an Atlantic crossing to supply that fuel. And one big raid uses up half its entire load.

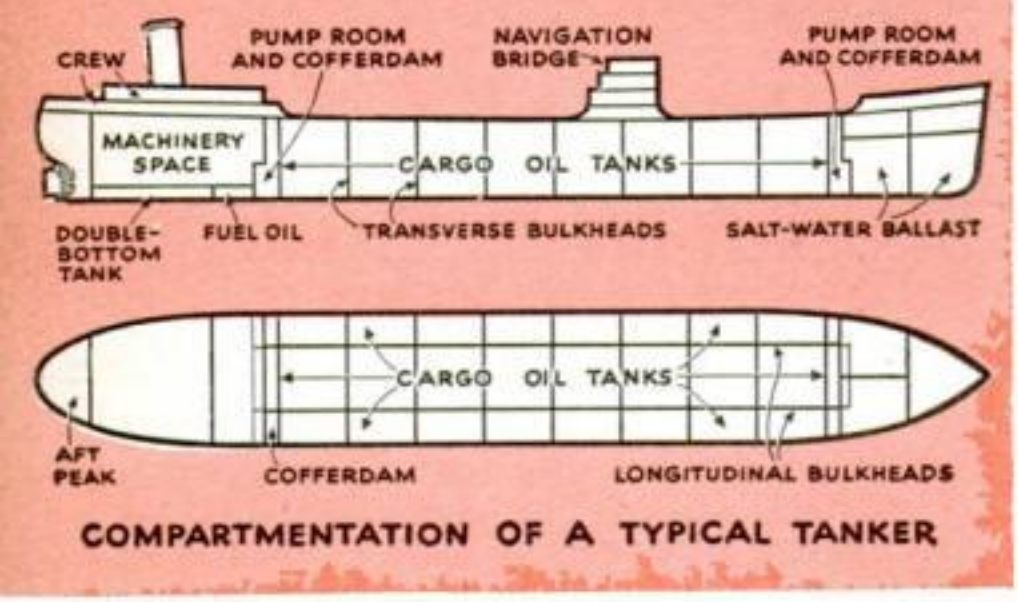
With an air force of tens of thousands of fighters, in addition to giant bombers, delivery of fuel to keep 'em flying moves to the front rank of war problems. Add to that the healthy thirst of an even greater number of motor vehicles in our mechanized columns, which also must strike at the enemy from foreign soil, and you begin to realize why the U. S. Maritime Commission and our War Shipping Administration place such warm bless- *(Continued on page 118)*

Photographs by WILLIAM W. MORRIS
Drawings by STEWART ROUSE

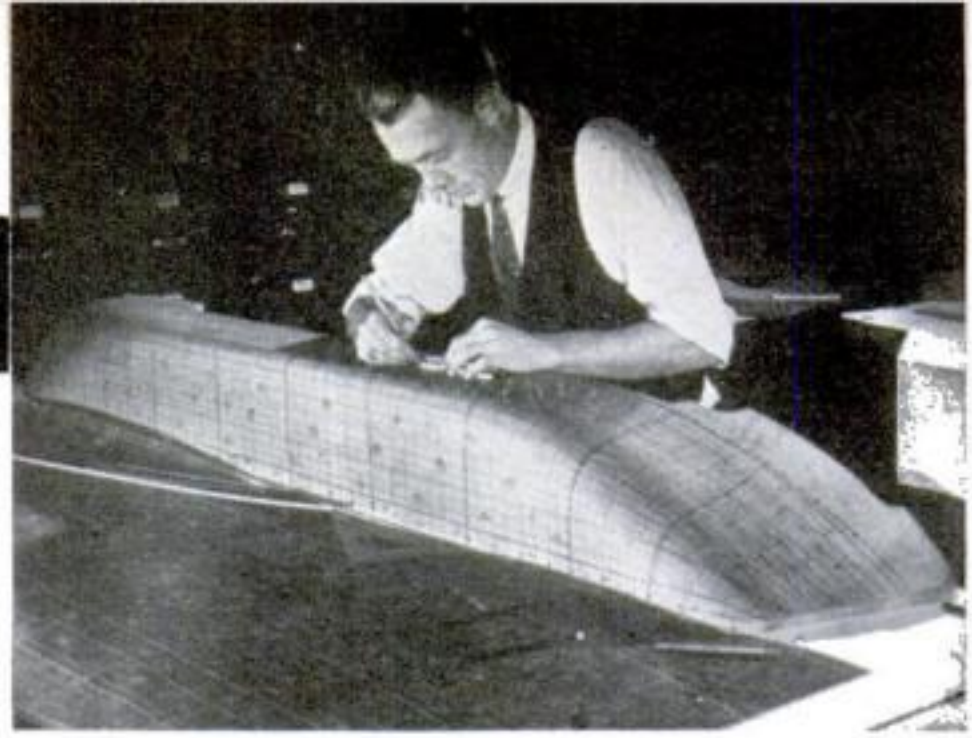


TANKERS

SHOP WORK: PATTERNS SPEED THE FABRICATION OF PARTS



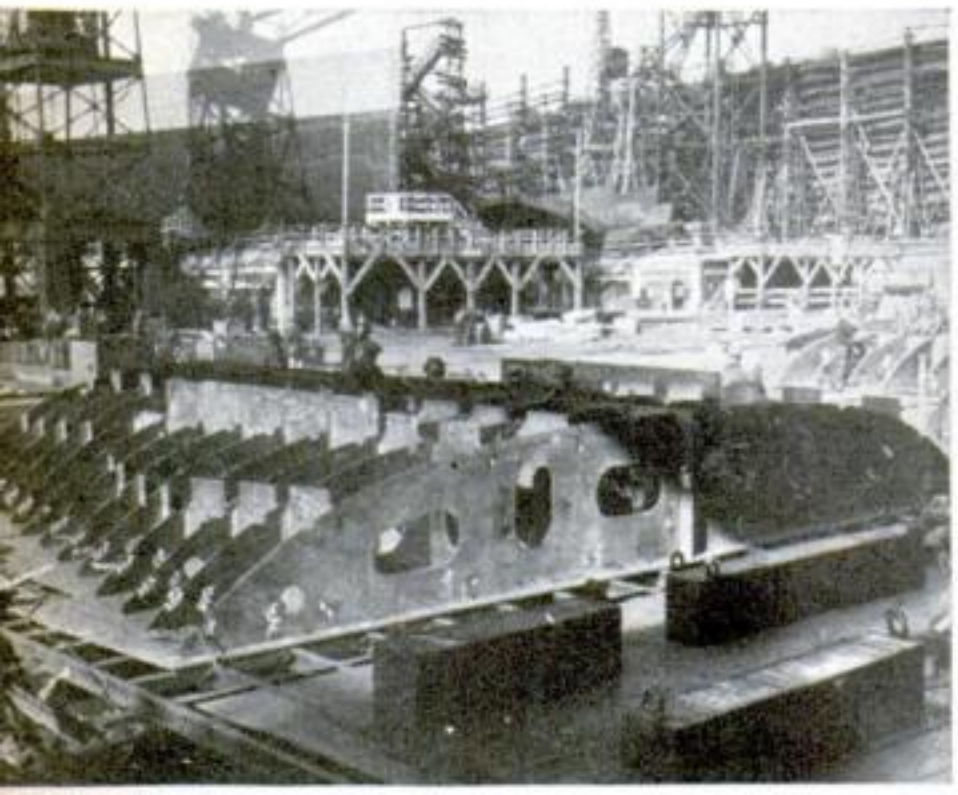
COMPARTMENTATION OF A TYPICAL TANKER

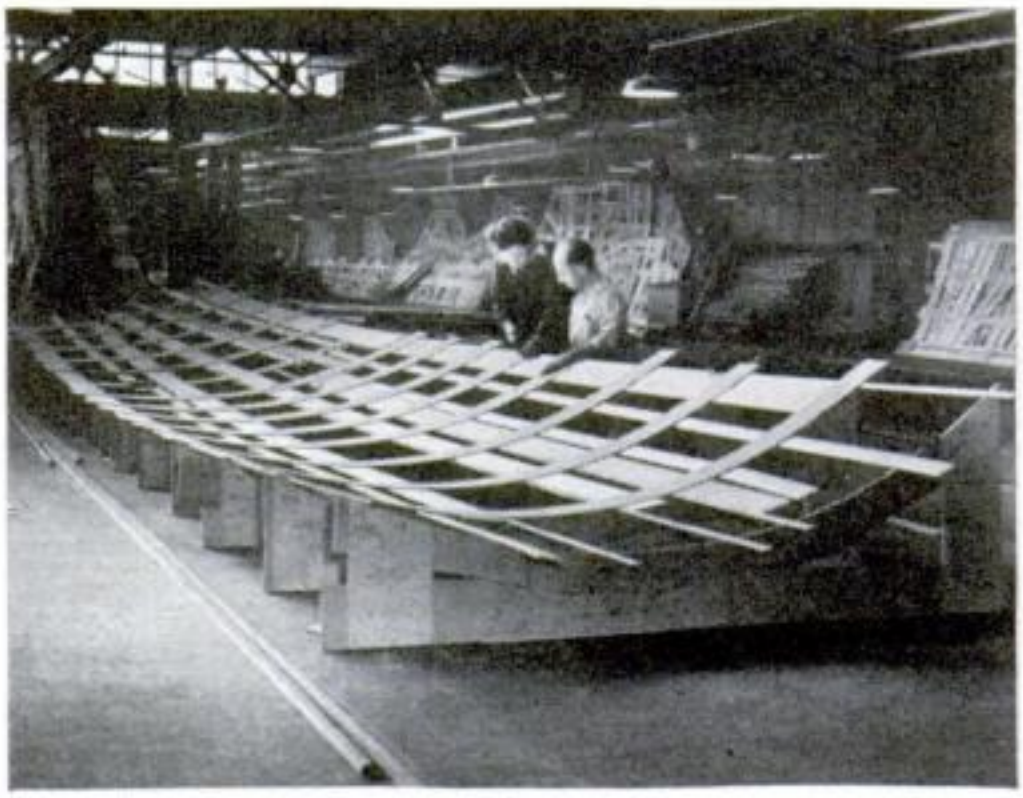


1 The first step in building the hull is to make a model scaled one-quarter inch to the foot. Depending on hull's shape, a draftsman decides how plating is to be done, then numbers and letters each plate on the model so that men in the yards will know at a glance just where each piece goes

4 This steel inner bottom, whose vertical sections have taken their shapes from the templates shown in the background of photograph No. 3, has been put together in a pre-assembly yard near the ways. While tankers look alike, each is built to carry a certain cargo on given routes

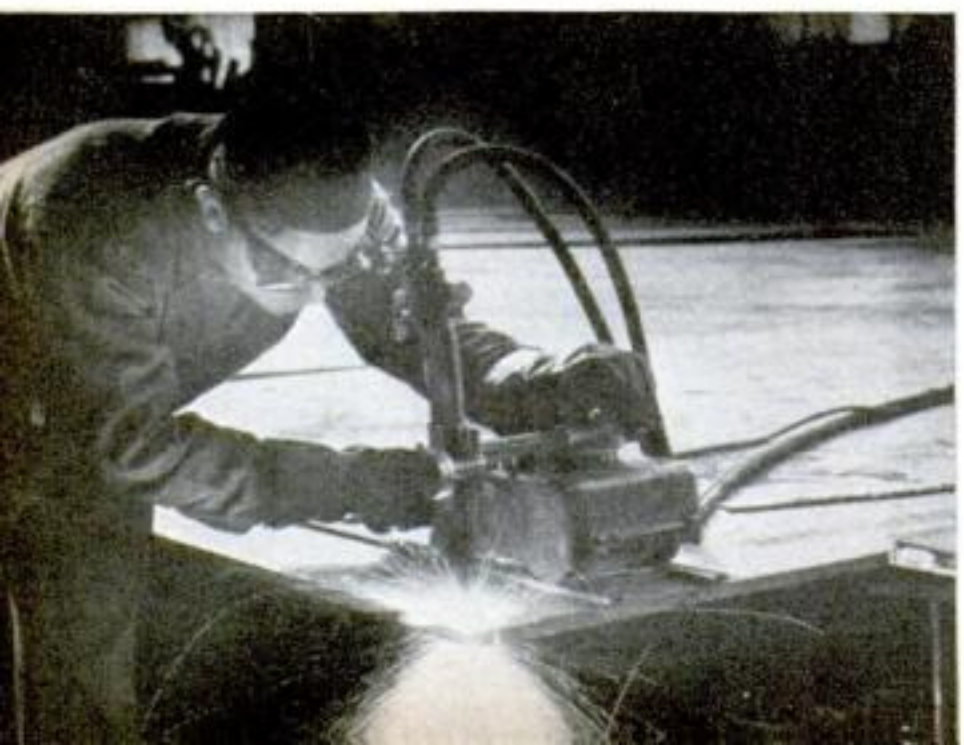
5 Another and tougher job of building a wooden template is the laying out of a mockup for a curved steel template on which a hot plate can be laid and pounded into shape (as shown at the right). This 31-foot wooden frame has been built as a pattern for a curved plate that will be used at the stern of a ship

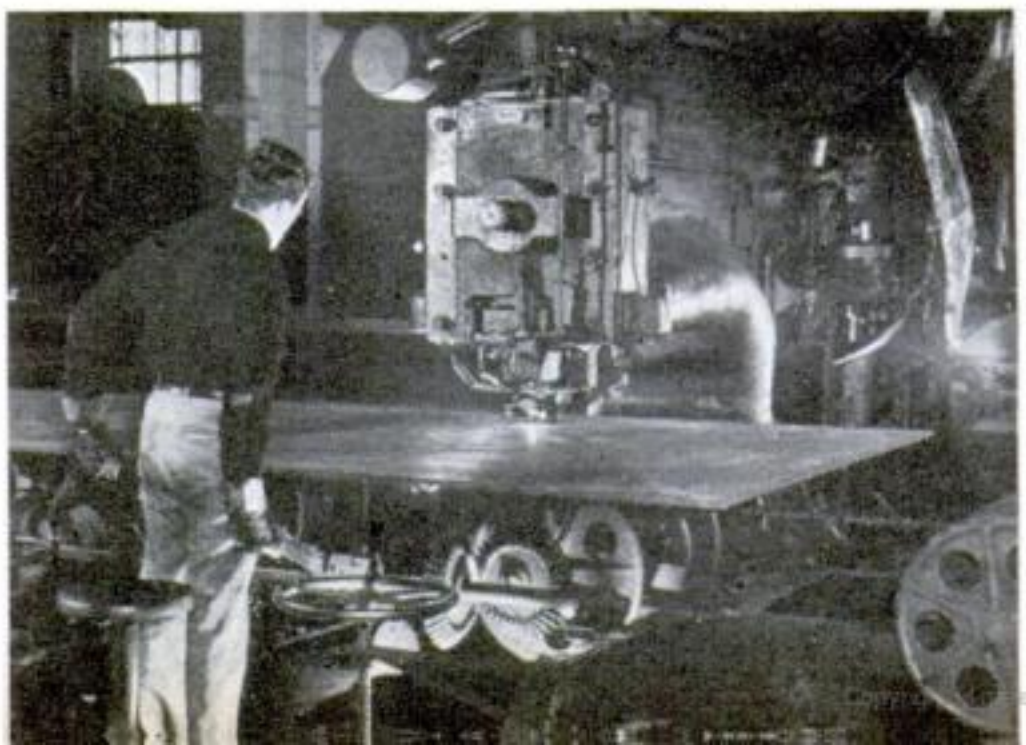


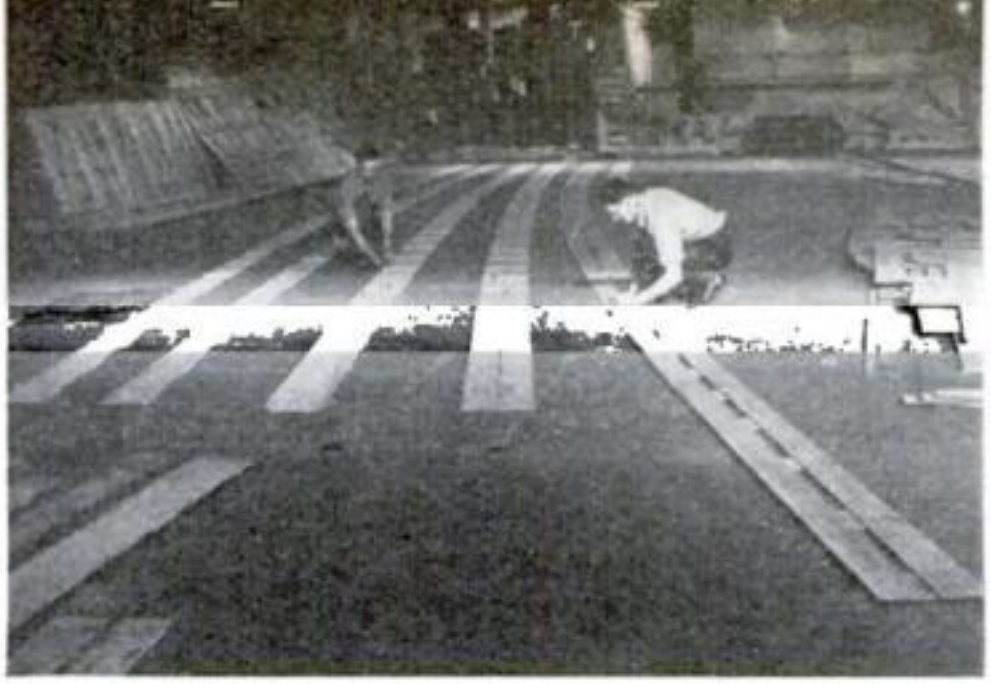


8 Following the lines marked in soapstone, the "burner" cuts and bevels the plates by means of automatic oxyacetylene torches that are propelled along tracks by tiny electric motors. The use of these automatic torches enables a burner to supervise three cutting jobs at the same time

9 Drilling rivet holes calls for dexterous hands and keen eyesight. Shifting the plate back and forth, and left and right, by means of two levers, this worker quickly positions the plate so that drill will come down precisely on each spot indicated by the markers. One slight miss, and the plate will have to be scrapped







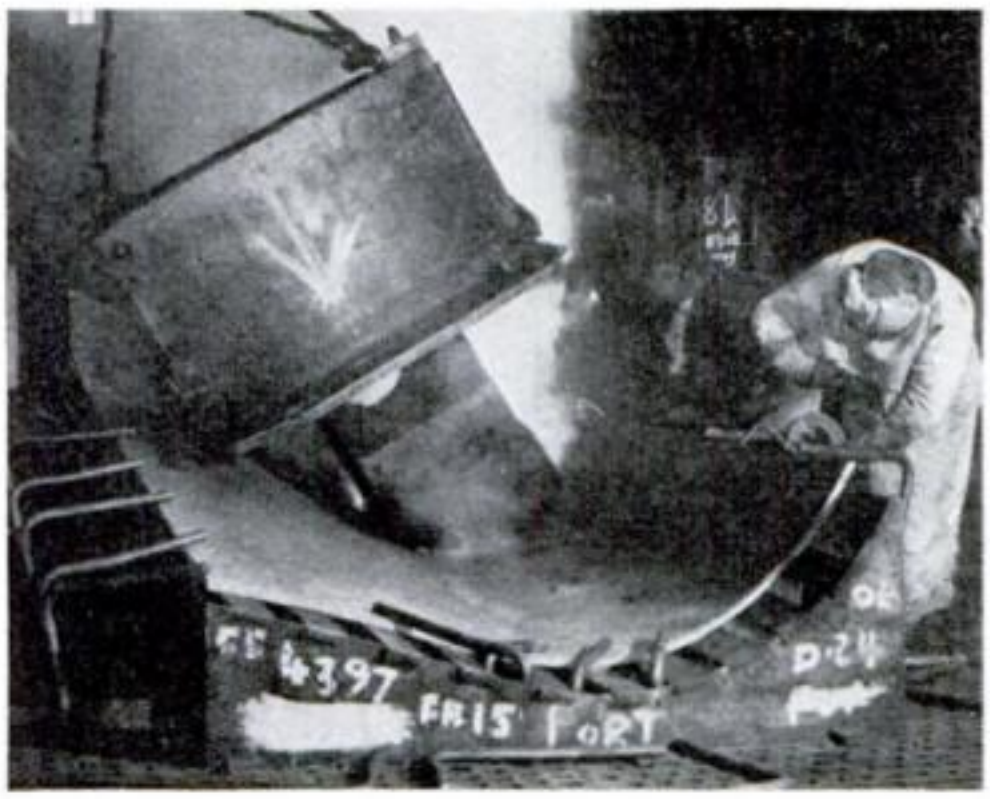
2 Following the lines on the model, workers in this 600-foot room lay out actual-size wooden templates which, like parts of a pattern for a woman's dress, serve as guides in chalking up steel plate for the cutter. When finally cut, the plate is marked with the same number and letter it was given on the model



3 The finished templates in the background will be used to mark up plates for the forward inner bottom of the ship. Those in the foreground will serve to mark plates nearer the bow. These templates are made of light and pliable pieces of pine that are held together by means of brads

6 An eight-ton weight box, with a great oaken beam for a hammer, is used to pound the furnaced plate. Striking at an angle, the beam slides along the plate with each blow. As it burns, it shapes itself to the curvature of the template. To protect themselves from the intense heat, workers must wear suits of asbestos

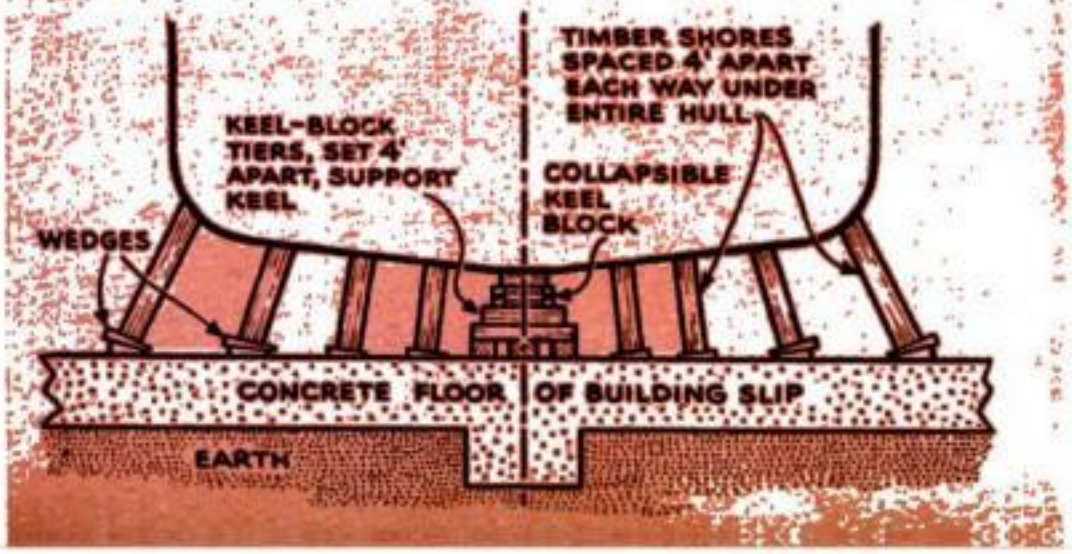
7 Laying out a plate from a wooden template includes marking up the plate for rivet holes, which is done with hammer and punch. Cutting lines are indicated in soapstone, and instructions are written on for the fabricating shop, in the event plate has to be heated and shaped

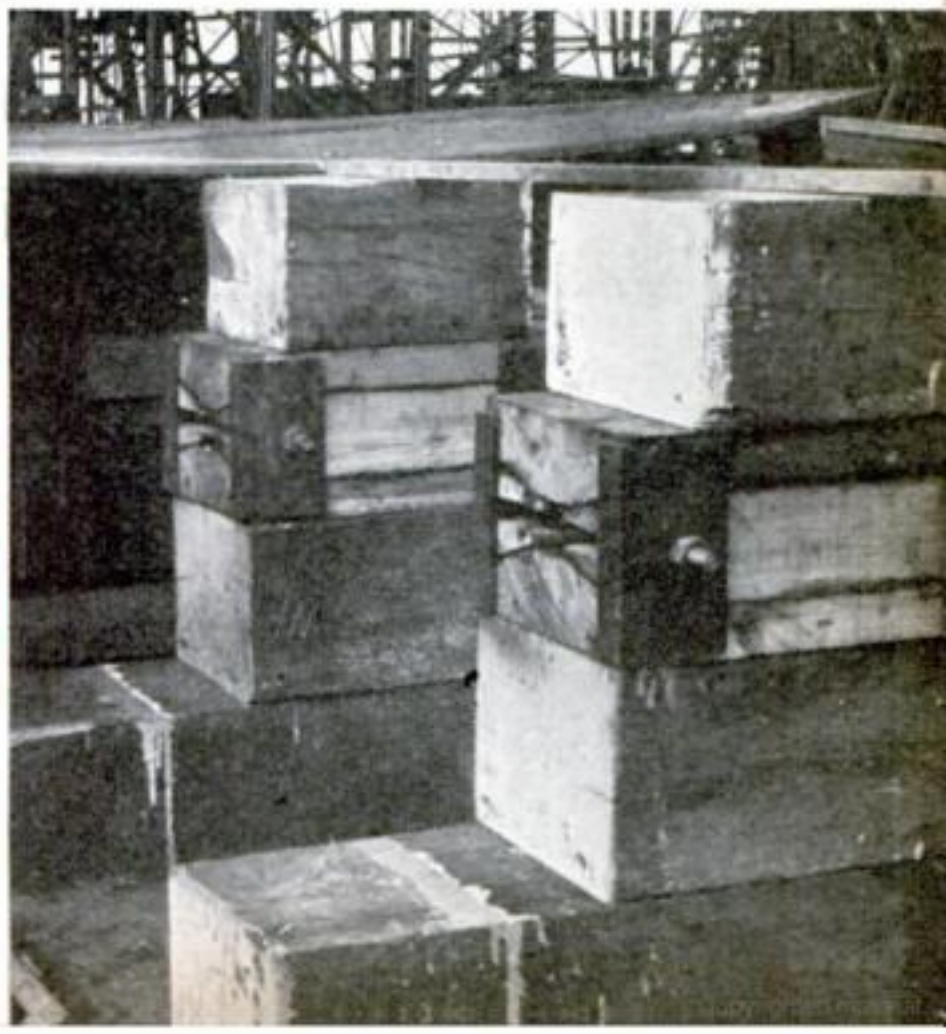




SUPPORTING THE HULL DURING CONSTRUCTION

While it is being built, hull rests on shores and keel block. When boat is ready to be launched, snug-fitting ways are substituted for shores, and keel block (right) is quickly collapsed by removing its metal flanges so that greased wedges can slide out





ings on every new tanker that is launched.

It was on a blustering, rain-drenched day that a writer and photographer of POPULAR SCIENCE MONTHLY received admission to the Bethlehem Steel Company's Sparrows Point shipyard. Cold wind whistled through towering works surrounding tankers under construction on the waterfront near Baltimore, Md. Rain beat in our faces. It was a fine day to sit at home by the fire. But that thought didn't seem to occur to Manager Frank A. Hodge and his thousands of busy workers. Their chief concern, we learned, had nothing to do with meteorology. It centered on their unfinished ships—ships destined to be completed on or before schedule —regardless.

Sparrows Point, we learned, has been keeping shipbuilding schedules since 1889. It built craft used in our last two wars, and it's well represented in this one. From its sloping ways on the sprawling Patapsco River has come as wide a variety of ships as you can imagine—sidewheel and packet steamers, coastal liners, tugs, colliers, torpedo boats, and tankers. Unlike yards building the Liberty ships and other one-design craft, "the Point" turns out "tailor-made" ships—vessels of special design to fill the special needs of a nation whose battle fronts thrust onward across the seas. It's prepared to construct as many as six different types of ships at the same time.

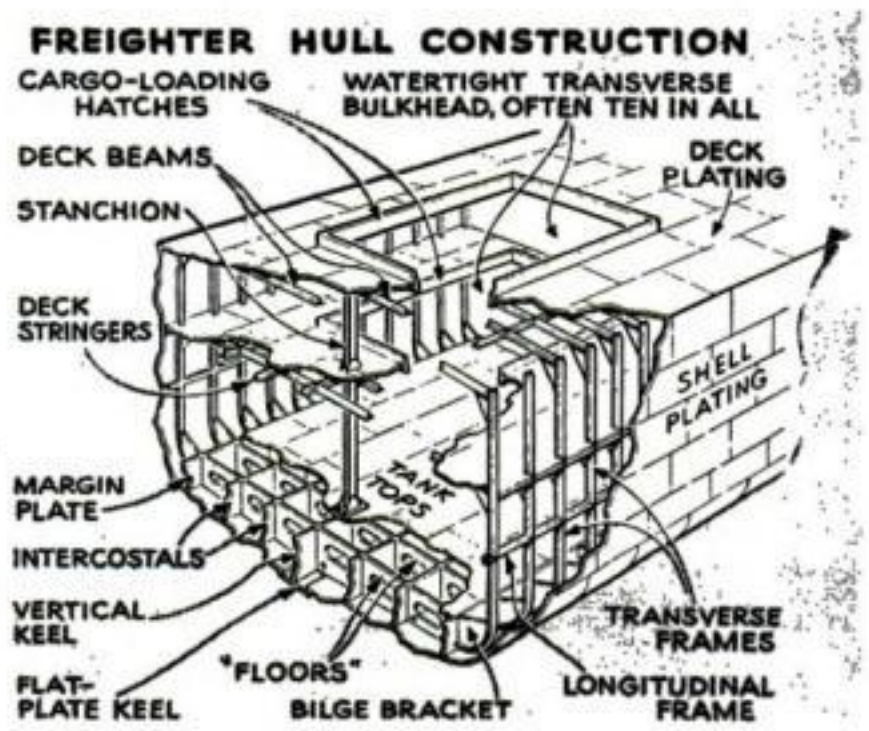
In building tankers, you have to have this kind of shipyard. For it's a fallacy to believe that because most tankers look alike, they're from the same blueprint. One may have to be built for long hauls, another for coastal service. A third may be designed to carry airplane gas, while her sister will pack cargo of crude or light oil. Still others must vary in draft to solve the problems of depth in foreign ports. In terms of construction, that means installing power, pumping systems, armament, and other equipment that has been made to order.

In making the 16,000-ton tankers that can haul as much as 6,750,000 gallons of high-octane gasoline on one trip across the Atlantic or Pacific, the shipyard works are necessarily of huge proportions. Scaffolding that lines the ways towers into the air. The tower cranes that stalk back and forth between the slips have a leg spread of 30 feet, and from the revolving penthouse atop them, their derricks can peek into a twelfth-story window. They lift big preassembled sections and lower them gently into place on the growing ships. Sometimes, when a piece is too heavy for a single crane, two or three of them, working together like well-trained giants from Mars, will share the load.

In striking contrast to the noisy ways is the cathedral-like quietness of the great 600-foot mold loft—on whose floor is laid a life-size diagram of the ship to be built. From this big diagram loftsmen make templates for almost every piece that goes into the hull and frame of the vessel. The templates, made of light wood, are as necessary to shipbuilding as patterns are to dressmaking. But they're considerably more expensive, costing as much as $100,000 for a ship of only 10,000 tons.

Cut, marked, and numbered, the templates go to the layout shed, where the steel plates are marked accordingly. Cutting and punching the rivet holes take place in the yard's fabricating shop, where the ship's frames, bulkheads, shell, and other metal parts are also made. Some of these can be

THE HULL AND BULKHEADS



Drawings above and at the right show how transverse ribs strengthen a freighter's hull while lengthwise ribs buttress tanker's sides. Tanks in a freighter's bottom are often filled with water for ballast. Below, three cranes share the job of lowering a heavy plate into place



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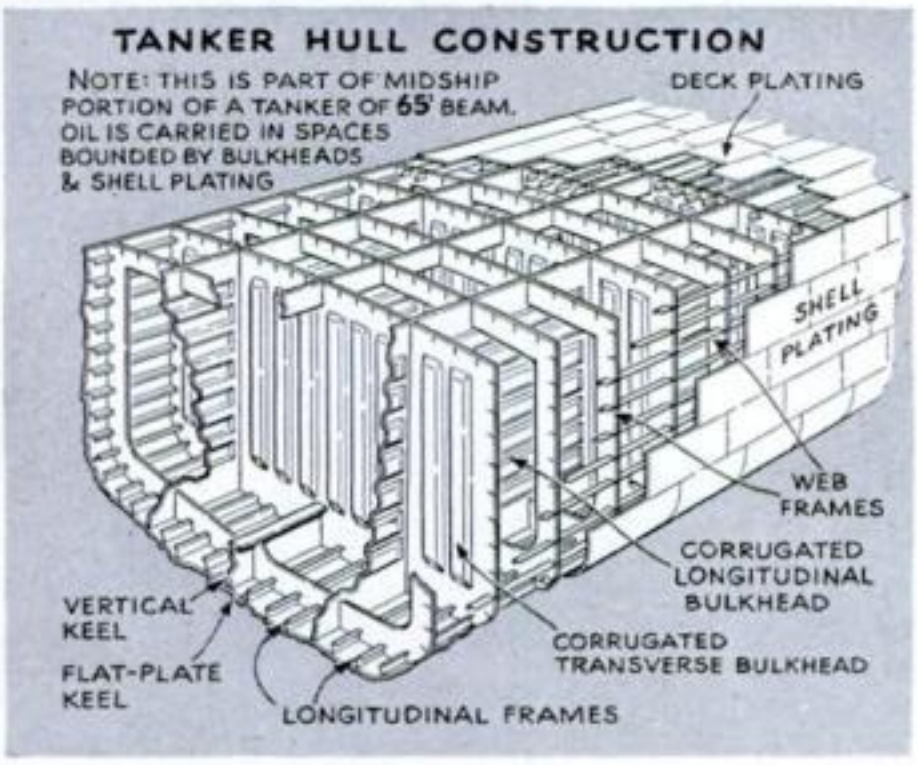


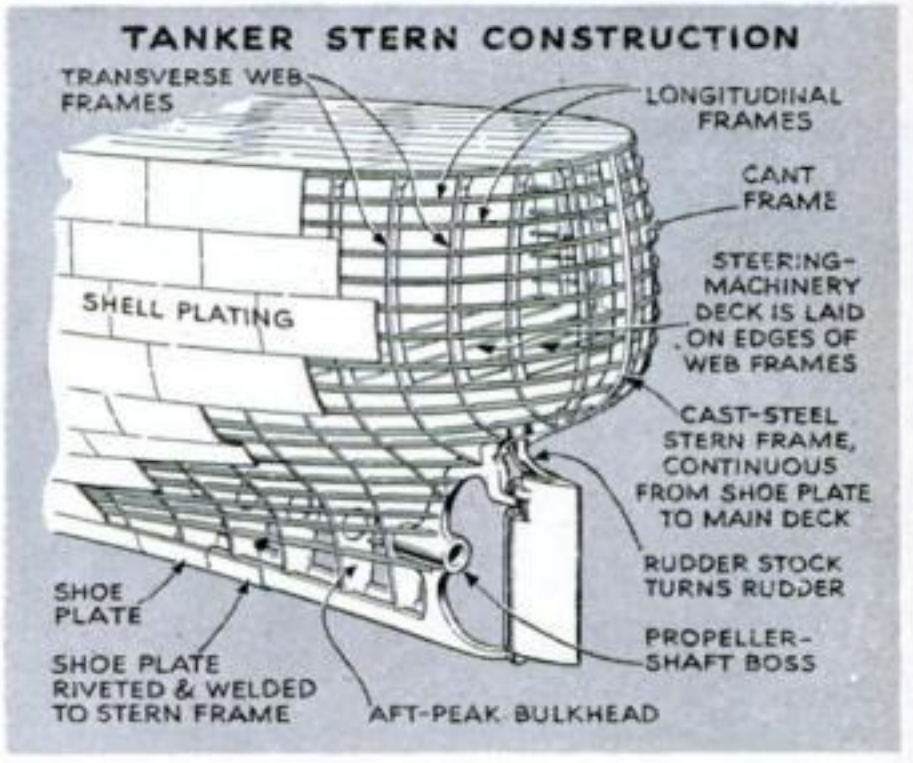
LAYING THE KEEL

Even the old-timers get a kick out of laying the keel for a new ship. Here the No. 1 plate is being lowered into place at the bow. Rows of plates—known as strakes—will be riveted to either side of keel to form ship's bottom

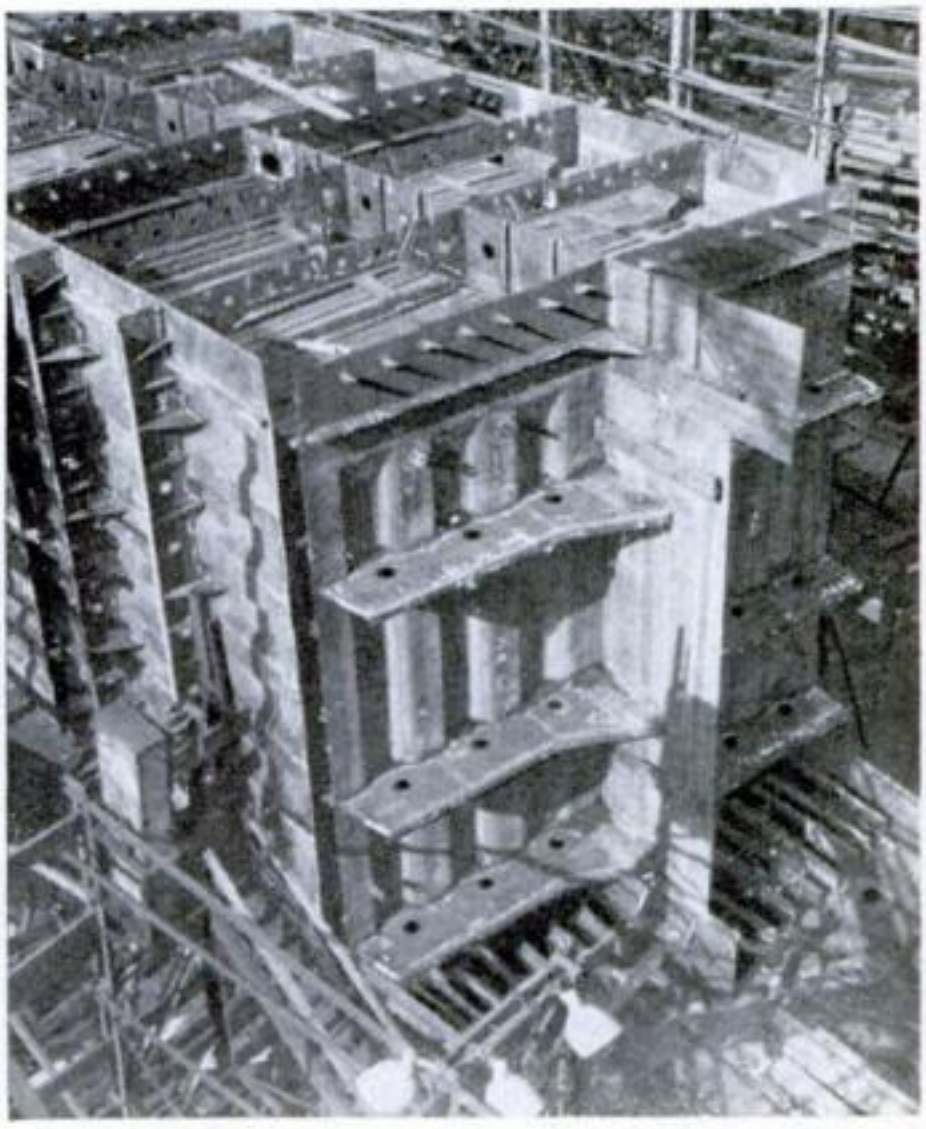
To the stern end of the keel is attached the "shoe," a troughlike plate in which will lie the propeller shaft and rudder post. Note the many holes for rivets, a great number of which are required because of the tremendous load the plate will have to carry

OF THE TANKER BEGIN TO TAKE SHAPE ON THE WAYS





The construction of a tanker's bow is similar to that of its stern (diagramed at upper right). Transverse bulkheads (below) combine with longitudinal bulkheads to form tanker's compartments (right). By being corrugated, bulkheads are made both stronger and lighter



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FASTENING SHELL PLATES

This view of a hull bottom near the stern shows how the plates are temporarily "laced," or hung on bolts. After the bolts are removed, the rivet holes are beveled from the outside, red-hot rivets are slammed into the holes from inside the hull, and their protruding ends are countersunk

Flattening the rivet ends into the beveled depressions of the holes is done with a pneumatic hammer. In figuring the amount of work done by a riveter, who is paid at a piece rate, checkers mark each completed rivet with white paint. Like welding, riveting is a tough job that is highly paid

CRANES HAVE THE BIG JOB OF ASSEMBLING THE PARTS

Only part of the seemingly endless stream of materials that flows into each ship is shown in the photograph at right. Gliding up and down on either side of this sprawling mass are gigantic cranes whose beams continually swoop down, snatch up a piece weighing anywhere from a few pounds to 50 tons, swing it over the ways, and drop it precisely into the right place on the ship. If a piece is too heavy for one crane, another will glide into position, and together they will drop the part smack on the line that shows where it is to go. The secret of these cranes' accuracy is the hand signals the ground men send up to the operator 65 feet above. Note worker signaling at lower right

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TANKERS

formed cold; others, emerging hot from near-by furnaces, are hammered into shape; some, which have to be bent, are twisted and held down with strong metal "dogs" on the flanger's slab—a large steel platform having squares which are somewhat similar to those on a waffle iron.

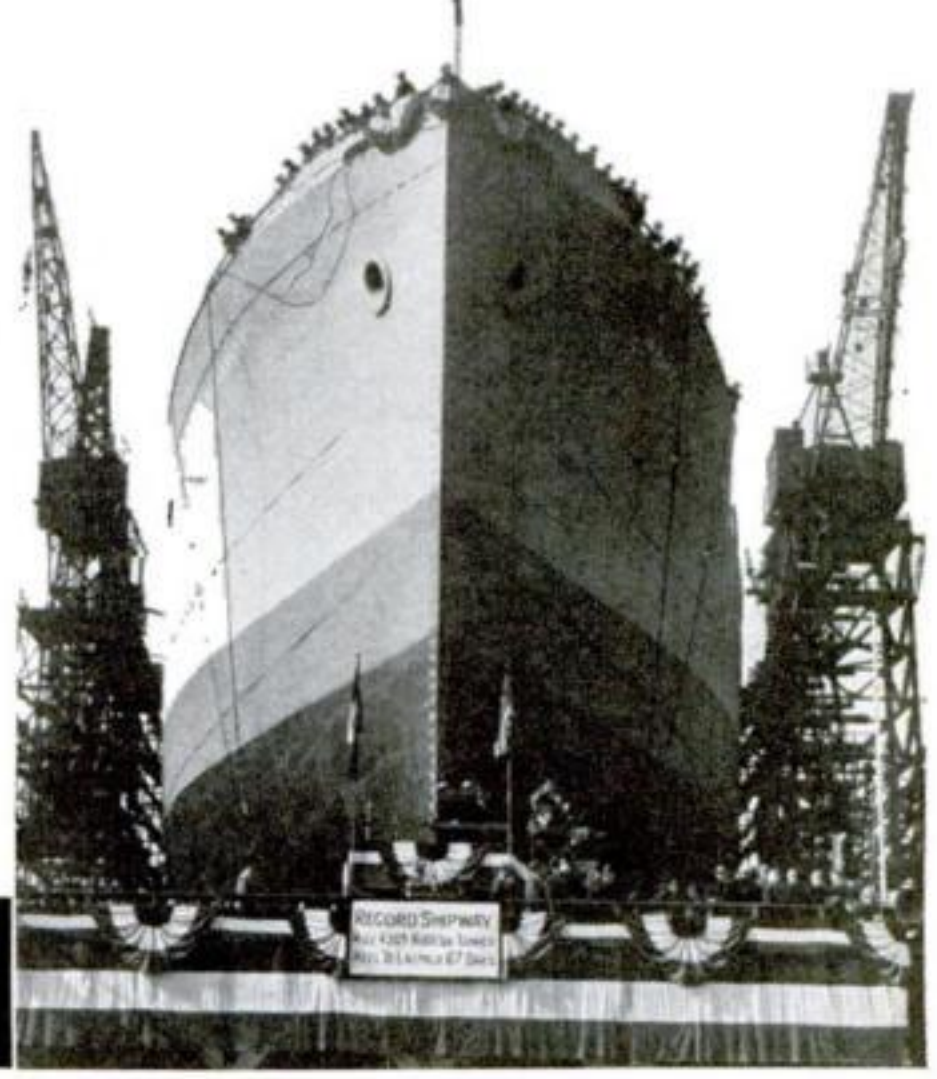
Construction time on the ways for tankers of 16,000 tons has been cut down from 4½ months to 67 days, an East Coast record which Sparrows Point shipyard has recently set. This has been made possible by new methods of handling steel with flame—burning and welding. Using a flame, a steel man can work with metal as a tailor works with cloth. With modern torches and welding equipment, steel can be taken apart and put together more easily than wood.

When a tanker is from 60 to 80 percent completed, she is launched. That's the big day for the yard, but it doesn't mean that the craft is ready for service. Many things have to be done before she can carry her cargo on the high seas. She's towed from the launching ways to the near-by outfitting pier—or wet docks—for finishing. There engineers, outfitters, painters, and electricians give her life. By man's genius, she gets power to swim around the world, power to see with searchlight eyes and to hear and speak through radio. Then off she goes to join her sister tankers in supplying fuel to keep the Allied motors of war roaring on every battle front.

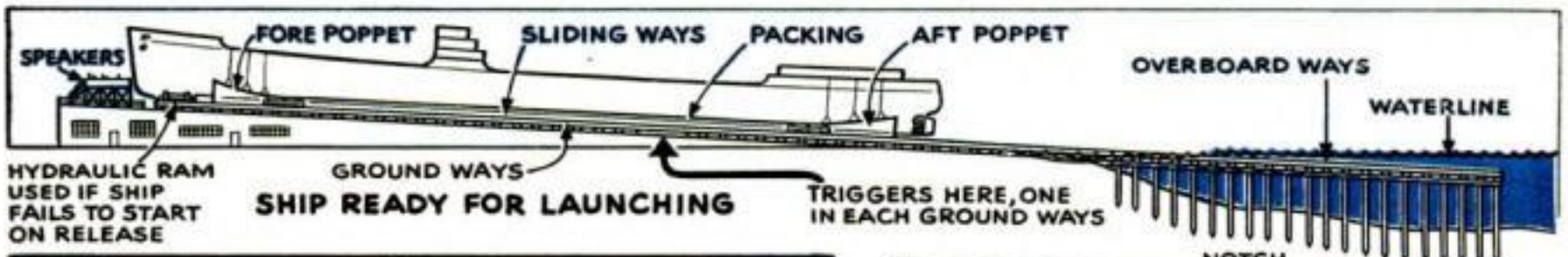


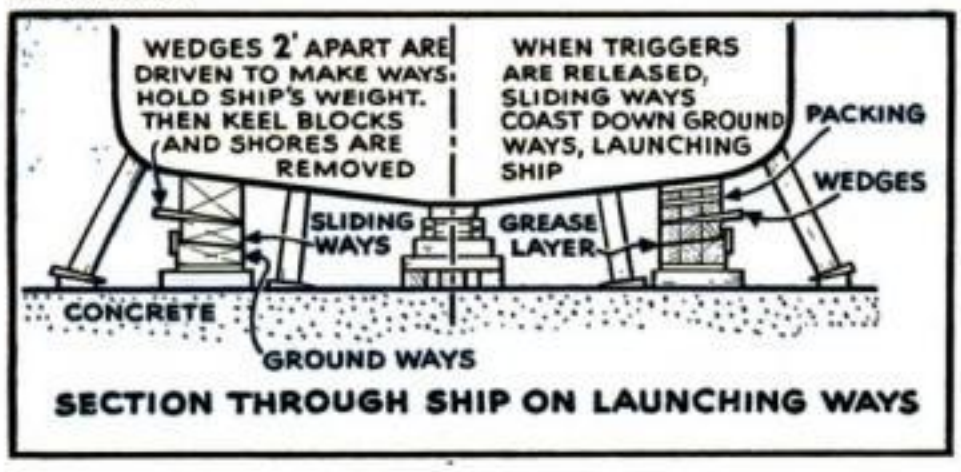
THE RUDDER is made by welding plates laid on a frame. Using an acetylene torch, the burner (farthest from the camera) smooths down any rough joints left by the fast-working welder. When completed, the rudder will hang finlike from carrier inside ship's stern

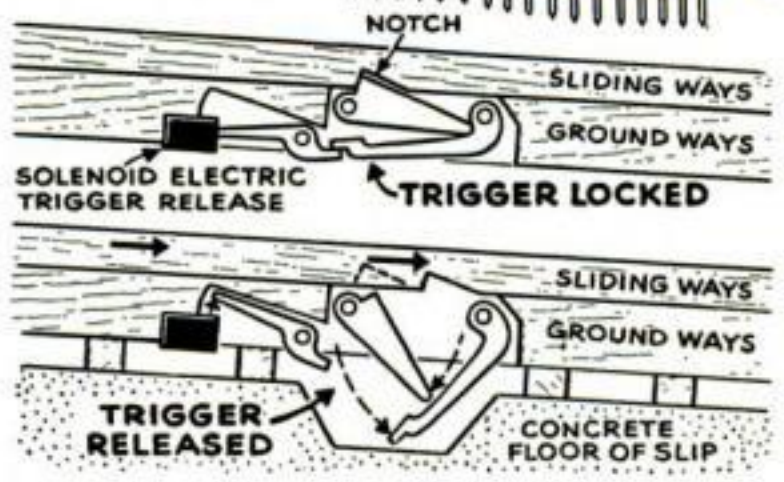
. . . AND ANOTHER TANKER IS READY FOR LAUNCHING



In place of holding plates, which had to be burned to release the ship, a trigger device is now being used to free the greased sliding ways that carry the ship into the water. By the time she "hits the salt," the ship will be moving at about 18 m.p.h.—faster than she will ever move again—and men will be standing by with hoses ready to douse the groundways should they ignite from the friction







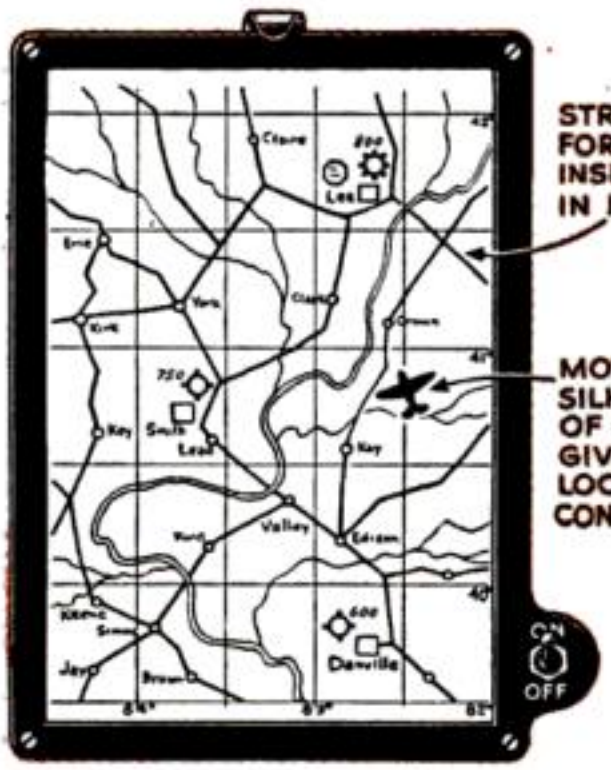
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No Traffic Jam in the Sky!

Green Light for the Air Age

Amazing visual instruments are predicted as a means of policing crowded airways in the postwar aviation boom.

Drawings by STEWART ROUSE



PILOT'S LOCATION INDICATOR

Postwar pilot may have sectional maps mounted in a frame, with a light throwing a small silhouette of the plane as it moves across the exact region spread out on the map before him

WILL the postwar period see the sky filled with aircraft moving safely about their business without fear of collision, traffic jams, and delayed landings? That is a problem of vital interest to the layman as well as to the aviation industry. It must be solved if our dreams of the coming air age are to be realized.

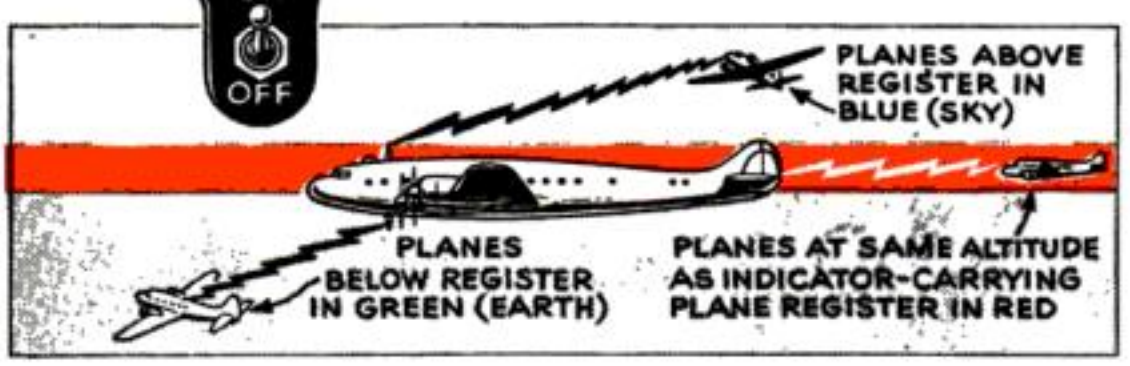
To do this, engineers of America's electrical and instrument companies have assigned many of their staff experts to develop devices for flight and traffic control to bring order out of what otherwise will be chaos. With war-sponsored developments in radio three-dimensional indicators and visualizers, it is quite probable that future air navigation and traffic control will be almost wholly visual on the part of both pilots and ground traffic-control personnel.

Up to 1930, airport traffic control consisted of a man on the runway with a red and a green flag; this was adequate, for traffic jams were few and far between. In that year the first radio-equipped control tower was built, and there were but an even dozen in the entire country three years later. Today, there are 35,000 miles of completely radio-beam and beacon-equipped airways in the United States alone. This system must be expanded to a global coverage and revised almost completely to handle the anticipated air-line and private air travel of the future. *(Continued on page 208)*



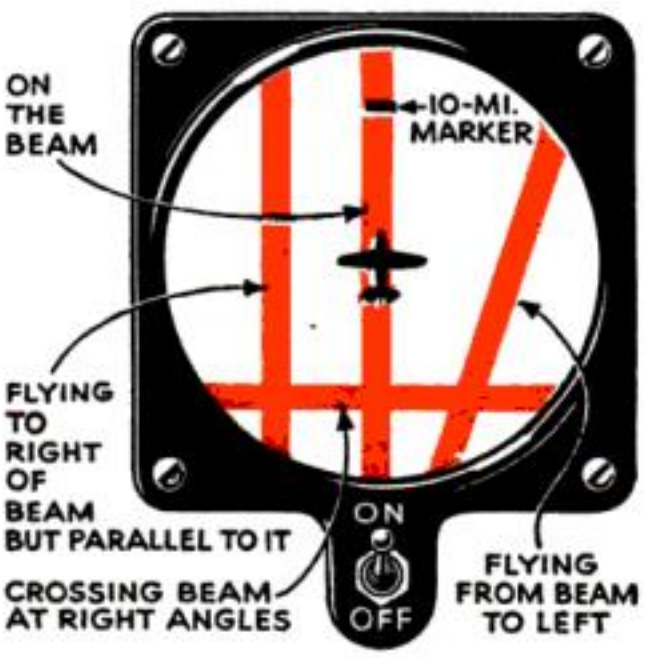
COLLISION - DANGER INDICATOR

Such a device would indicate the direction, proximity, and relative position of the planes near by. As planes vary altitude with relation to instrument-carrying plane, the spots representing them on the dial change their color accordingly

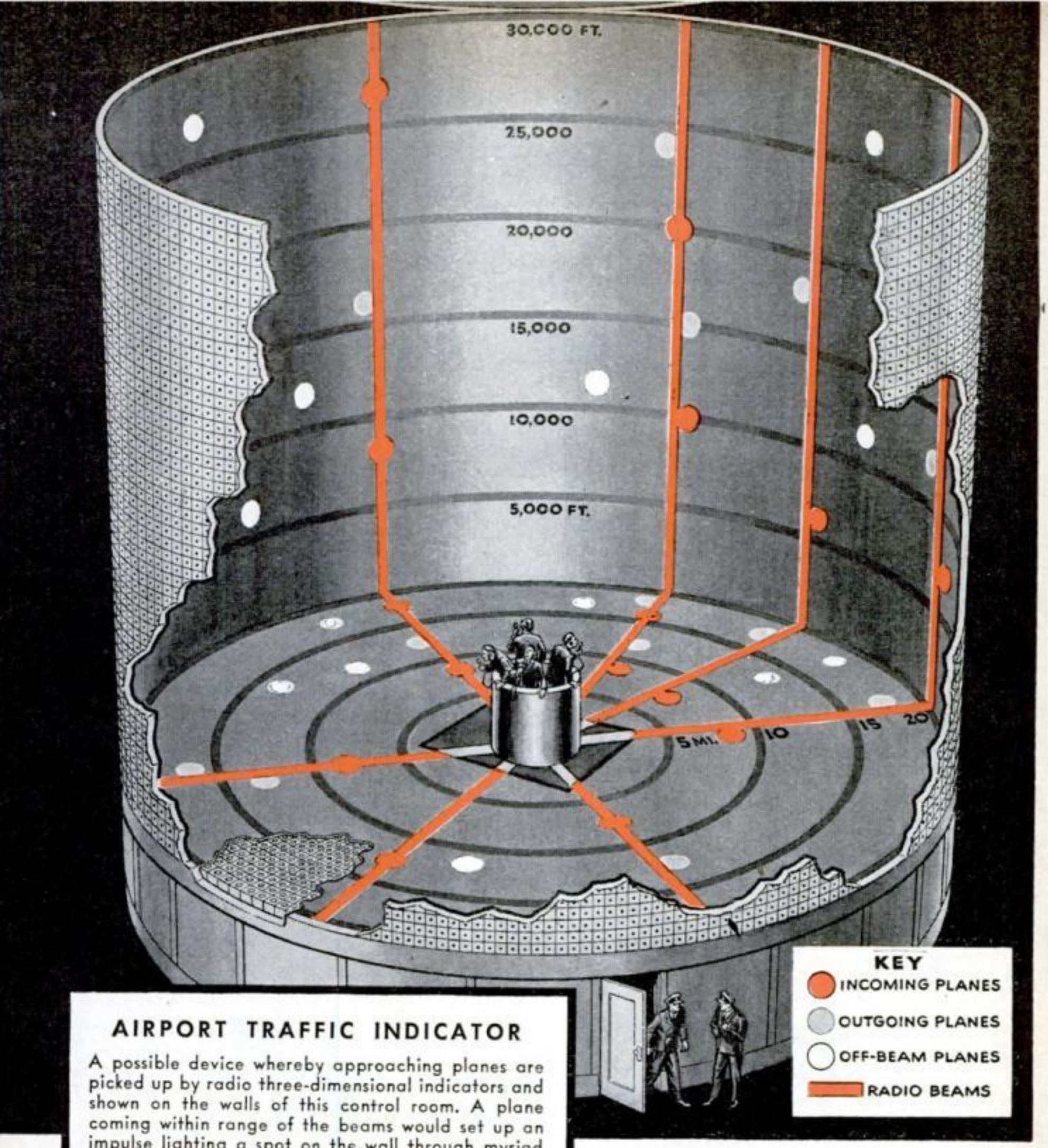


VISUAL BEAM INDICATOR

May indicate by a moving line the position relative to the beam. Plane image, showing course, is fixed. Arrows point to four situations. Breaks in image show the location and mileage



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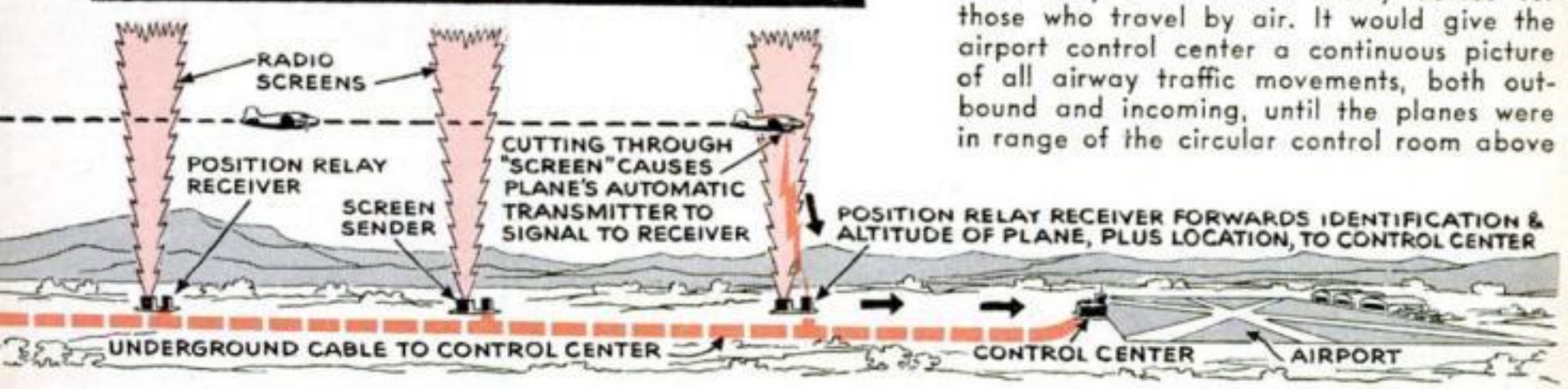


AIRPORT TRAFFIC INDICATOR

A possible device whereby approaching planes are picked up by radio three-dimensional indicators and shown on the walls of this control room. A plane coming within range of the beams would set up an impulse lighting a spot on the wall through myriad backlights. Incoming planes would be shown in red on painted beams by a signal growing stronger; outgoing, in blue, by a diminishing signal. Off-beam planes show white. Wall markings give altitude, and floor markings show proximity of planes to airport

AIRWAYS POSITION INDICATOR

This automatic position and altitude indicator may be a future safety device for those who travel by air. It would give the airport control center a continuous picture of all airway traffic movements, both outbound and incoming, until the planes were in range of the circular control room above



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SHIPS THAT



Carpenters at the Mingsung Shipyards, Chungking, China. Workmen bring ingenuity and skill to bear on difficult problems of shipbuilding and reconditioning. Here they are shown using a primitive drill in preparing decking for one of the boats that are being made seaworthy after Jap strafing

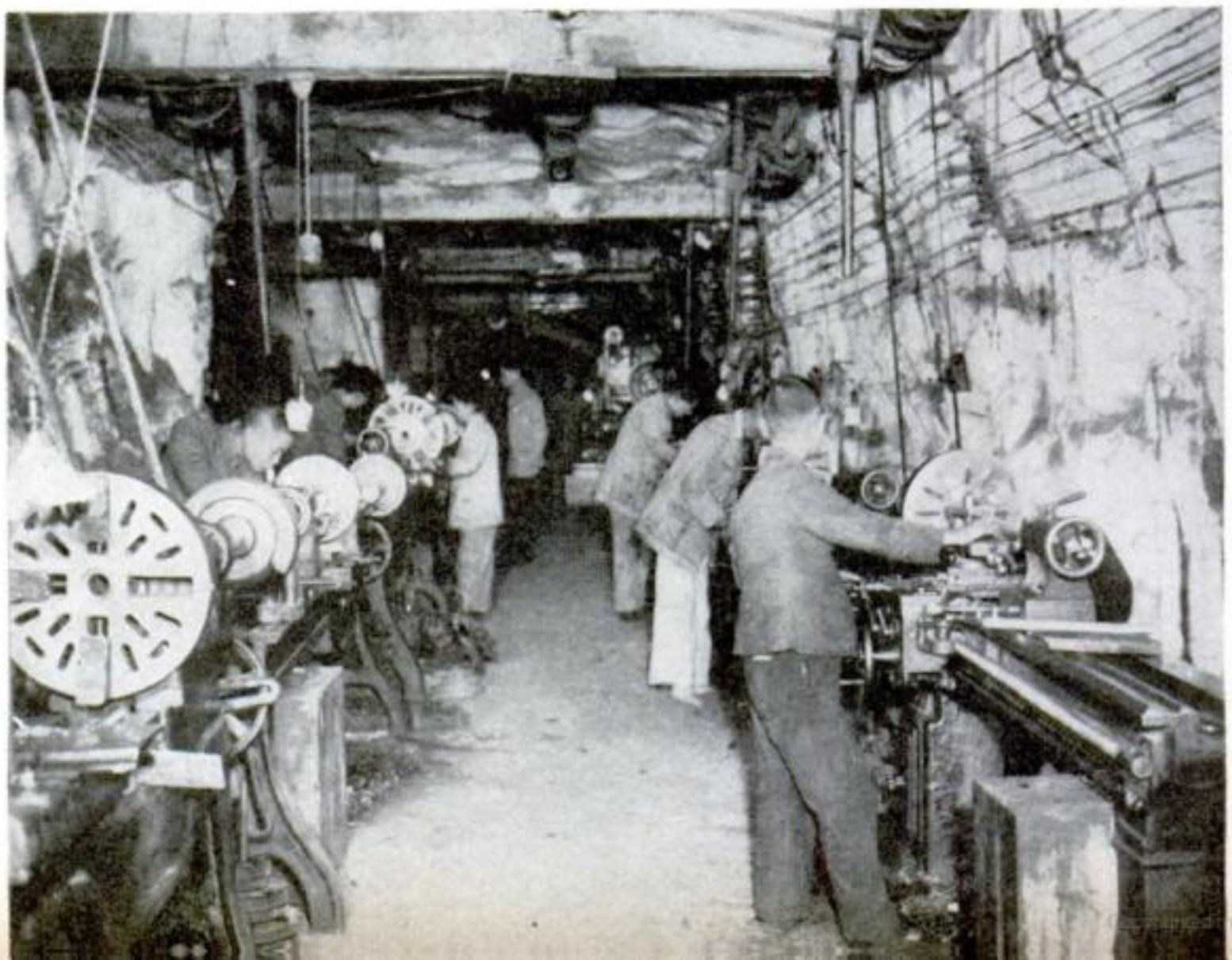
CHUNGKING, CHINA. *(By Radio)*

SHIPS the Japs have bombed and sent to the muddy bottom of China's Yangtze River are carrying war materials to blockaded Chungking again. Divers may have to go down 60 feet to salvage a boiler; an engine may be rebuilt with homemade parts; a wrecked ship may have to be sliced in two and lengthened—but when it is launched it steams away under its own power.

That is the story of determination and ingenuity you can see enacted along the mile of water front that is the Mingsung Shipyard near Chungking. There on the sandy and rocky beach, a dozen vessels ranging from "wooden Liberties" to a converted passenger steamer are being readied to take part in China's vital wartime and postwar river traffic.

The Mingsung yard could not be confused with one of Henry Kaiser's plants, for it has its machine shops in a 2,000-foot dugout hacked into the solid rock of a steep hillside. Fifty *(Continued on page 199)*

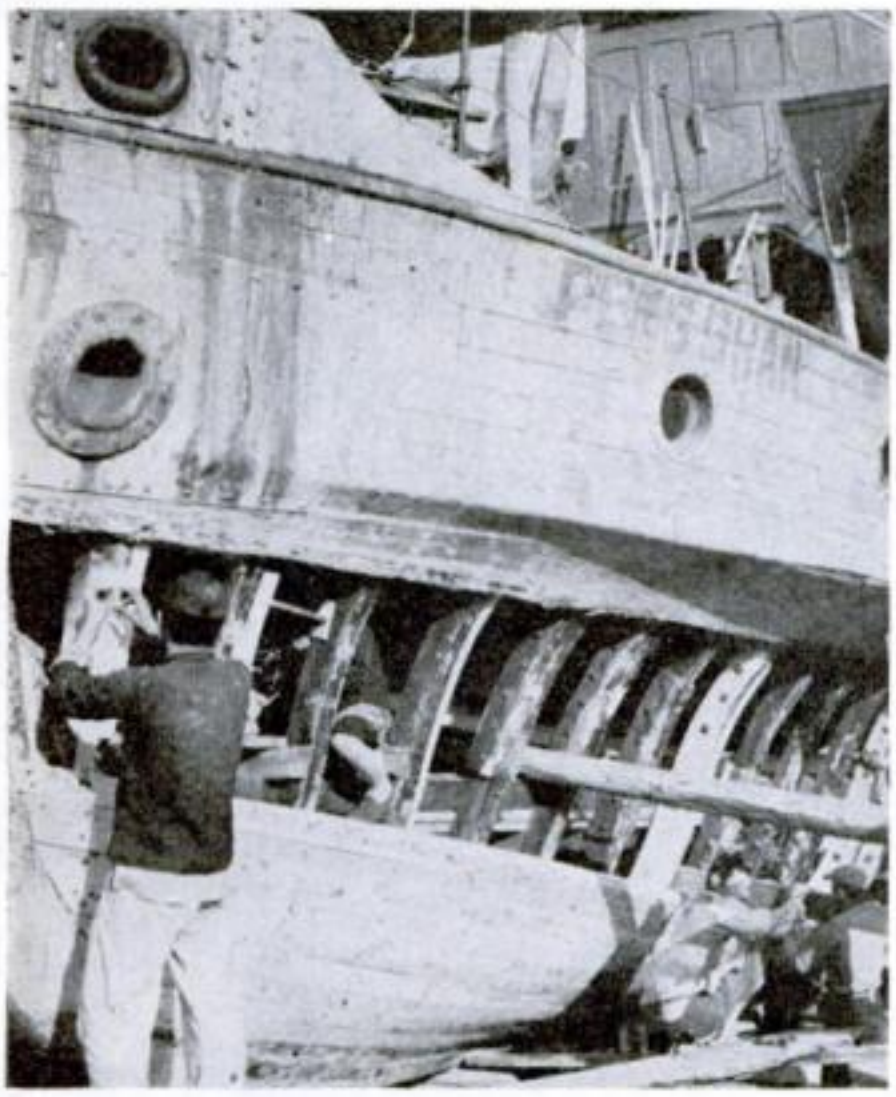
沉舟重起



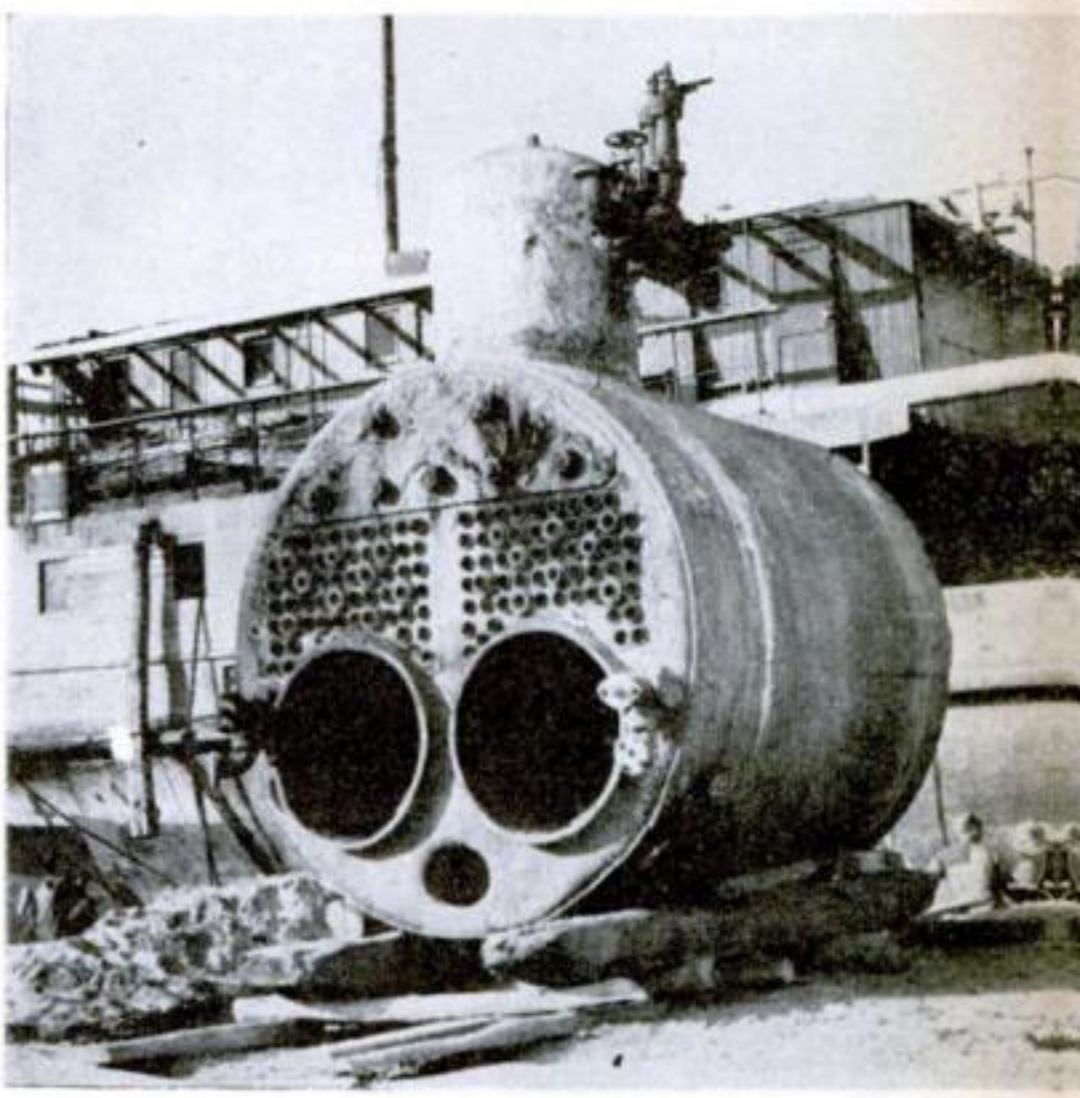
Adjoining the shipyards are the machine shops in a cave cut for 2,000 feet in the solid rock of a steep hillside. No Japanese bomb could penetrate the 50-foot thickness of rock that separates the workers from the ground above. Through air raids, work has continued with the improvised equipment plus Chinese efficiency

WON'T STAY SUNK

In spite of Japs and high water, ingenious Chinese shipwrights keep a fleet of vessels on the Yangtze



After this Japanese-bombed wooden ship has been reconditioned by Chinese workmen, it will steam away from the shipyards for war service

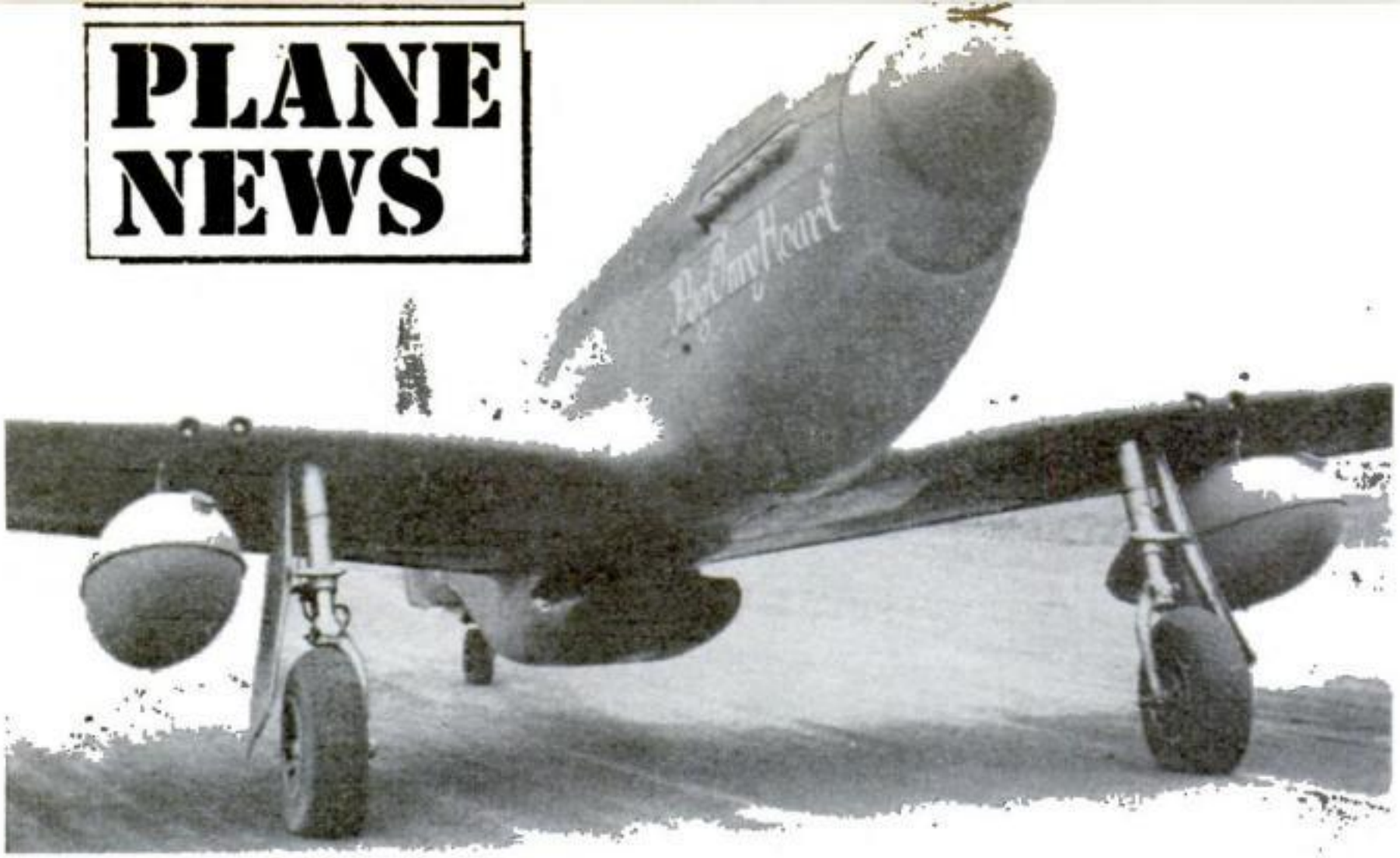


Divers have had to go down 60 feet to salvage a boiler from a bombed ship. This boiler, American built, was raised from the Yangtze, and awaits installation in a repaired vessel

A damaged ship that is to be overhauled for additional wartime duty is pulled up the ways from the Yangtze River at the shipyard by the hand winches shown in foreground. By June, every vessel must be ready to float, for early that month the river rises as much as 90 feet, and an unseaworthy ship would founder in the shipyard



PLANE NEWS



CLAIMED TO BE THE BEST all-around fighter plane in the world, the new P-51B version of the familiar North American Mustang sports a four-bladed propeller driven by a Packard-built Rolls-Royce Merlin engine. Addition of the wing tanks shown enables the P-51B to convoy heavy bombers to target areas over 400 miles from home, fight, and return. Fuel from these tanks is used on the way out, saving standard fuel load for fighting and the return trip. Tanks are dropped as combat area over target is reached. On shorter missions, bombs may replace these tanks.

TO HOLD ENGINE COWLINGS of high-speed warplanes, a new fastener invented by Dr. E. L. Mack and perfected by the Aircraft Parts Development Corporation is manufactured by the Elastic Stop Nut Corporation. The fastener, illustrated and diagramed below, is a spring-lock device, light in weight but rugged in construction. The Army Air Forces have found that it meets specifications for use in any Army airplane. It has been similarly tested and passed by the Navy's Bureau of Aeronautics. Vibration-proof and quick-acting, it will have many postwar uses.



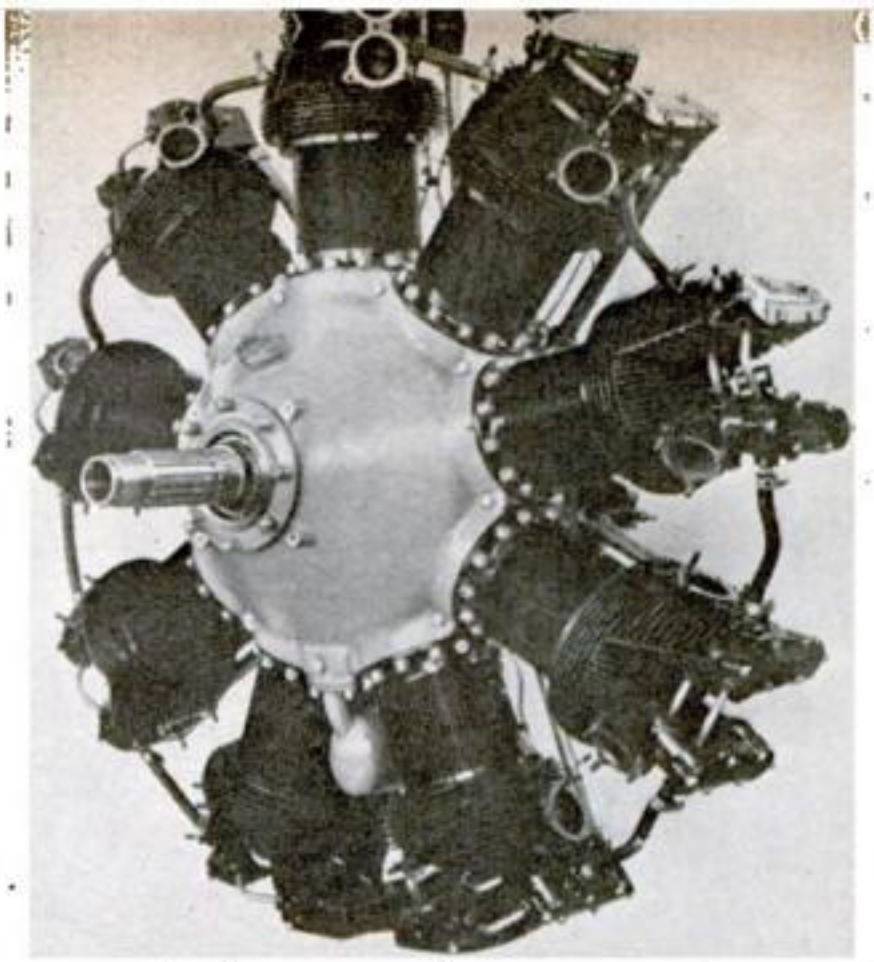


HE IS BRIEFING PILOTS of fighter planes with a new multilevel table that shows line-up for a projected mission. Tiny model planes are arranged on the glass plates, separated to represent graphically the different altitudes at which the bombers and fighters will fly and the formations they will assume on their approach to the target area. Capt. G. J. Burris, of Canton, Ohio, military intelligence officer of a new P-51B fighter squadron in England, is shown demonstrating the table.

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AN "IMPACT SWITCH," shown below, is a new safety device that automatically actuates the discharge of several pounds of liquid carbon dioxide into the burning engine compartment when a combat plane crashes. It was developed by engineers of Walter Kidde and Company as an automatic fireman to release clouds of fire-quenching vapor even if the pilot has been rendered unconscious. It is also called a "crash switch."





A NEW ERA in safety, economy, and efficiency in aircraft engines is heralded with the Guiberson Diesel. This 310-hp. engine, product of the Guiberson Diesel Engine Co., of Dallas, Tex., does away with ignition trouble, flash-fire danger, carburetor icing, and complicated servicing.

A SAFETY SHUTOFF that acts in the event of a ruptured or bullet-pierced hydraulic system of an airplane is being made by Simmonds Aerocessories, Inc. The hydraulic fuse (quantity-measuring type), illustrated below, shuts off escaping fluid after a measured quantity has passed through it, thus saving the remainder of the fluid supply in the hydraulic system and permitting the rest of the system to be used. Variations in oil viscosity or rate of flow do not affect the successful operation of the fuse, nor do back pressure, surges, or large amounts of air that may be left in the hydraulic system.

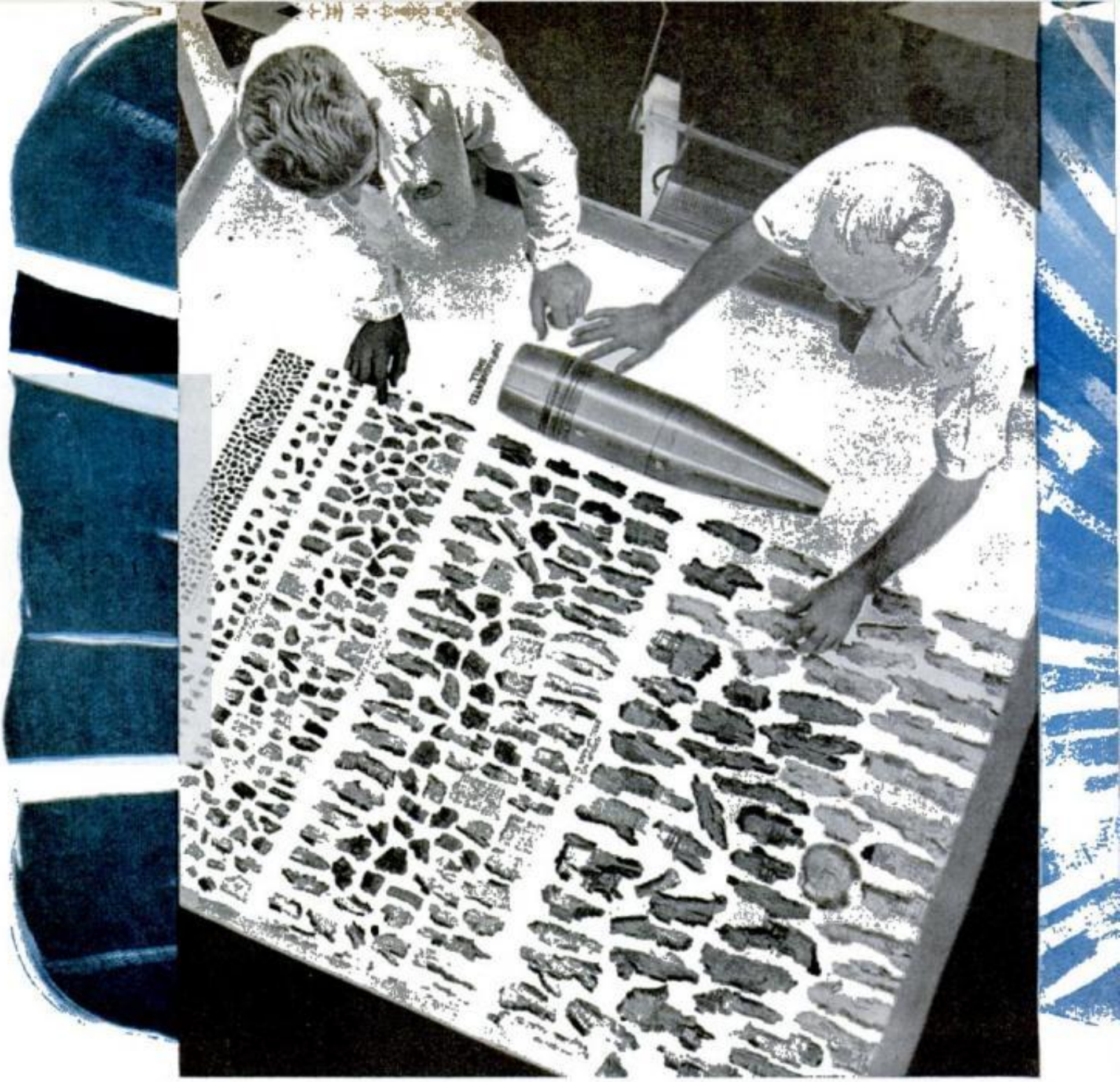


BELL HELICOPTER designed by Arthur M. Young is powered with a Franklin air-cooled engine behind the pilot. The rotor consists of two blades kept at the proper pitch by counterbalances on rods below the rotor itself. The counterbalances turn with the rotor blades. The helicopter has a tricycle landing gear and is metal-covered throughout. It seats two, side by side, and the cabin has full automobile-type doors. This model, No. 2, has been flying since October 1943 and is constantly improved.





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The grim story of what can happen when a "fast" explosive lets go is told in these jagged pieces of steel trapped in sand during fragmentation test of a 155-mm. shell

Teaching Explosives to

They're just fast-burning chemicals that pack a punch . . . There are many kinds, and each kind has its own particular job to do in war as well as in peace.

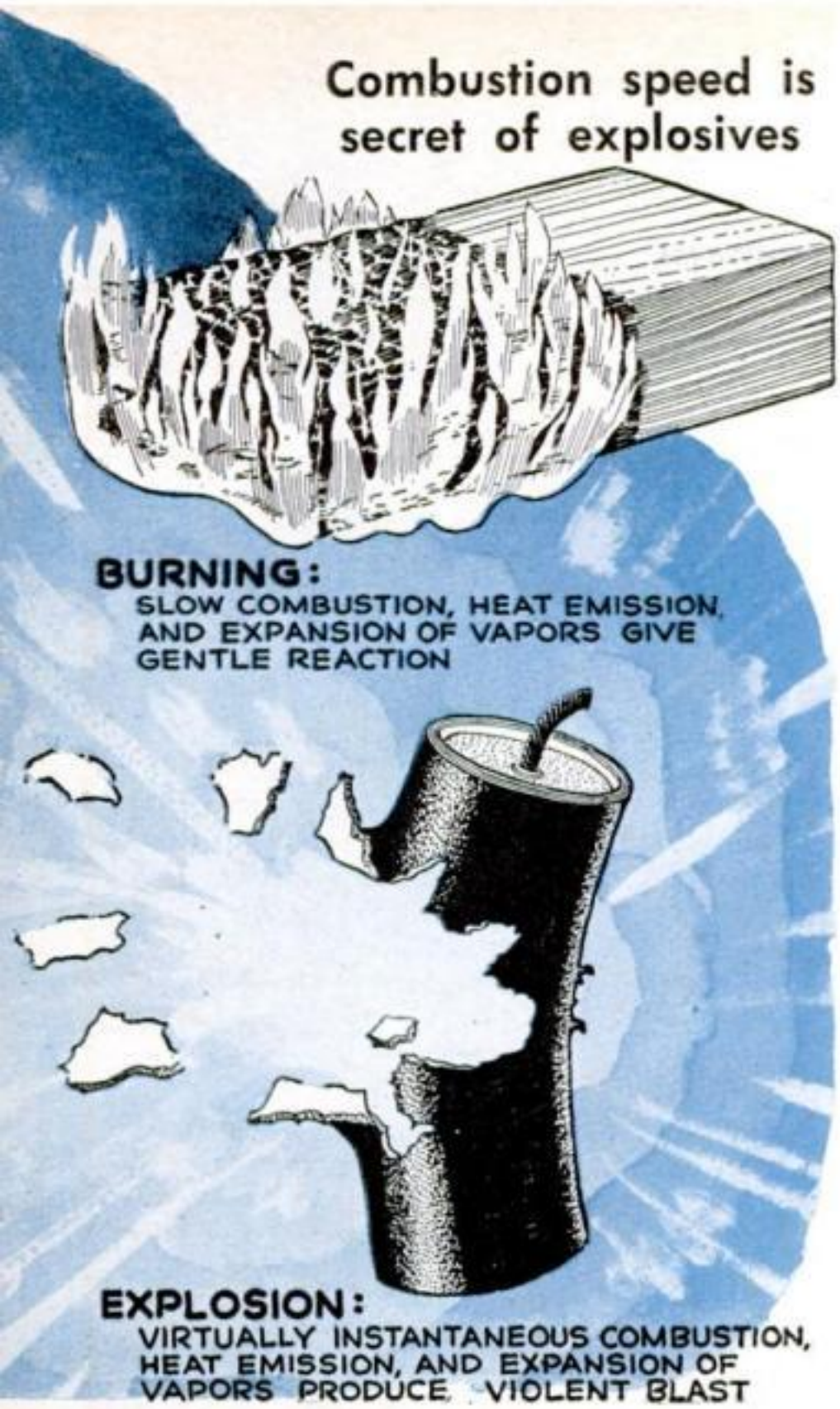
By

ALBERT Q. MAISEL

MODERN WARFARE is the art of using explosives to throw explosives. In any battle, the side which can throw the largest quantity of explosives the greatest distance and with the greatest speed usually comes out the winner.

But what are these things we call explosives? Most of us think of them as powerful, violent chemicals which go off—that is, explode—on the least provocation. Actually, any explosive which meets this definition is usually too sensitive for wartime use. The best known of the high explosives, TNT, is so insensitive that it will not explode even if hit directly by a high-powered rifle bullet. As for power, there is

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Drawings by STANLEY BATE

Do Tricks

actually more energy in a pound of coal than in a pound of TNT.

The secret of explosives lies in their control. They must be used in such a manner as to release their power suddenly, at just the right second and in just the right place. With industrial explosives, the right time means when everyone has moved out of the danger zone around the explosion, and the right place may mean that point in a bore hole which will break away just the desired amount of rock. With military explosives, there are even more precise demands as to time and place, for a shell *must not* explode under the impact of firing it from a gun, but it *must* explode at a predetermined second.

Actually, explosives are simply compounds or mixtures which burn. But they differ from ordinary burning things in two respects; they burn much faster, and most of them carry their own oxygen supply. When you burn a piece of wood, its outer surface combines with the oxygen in the air, and a large part of the wood is transformed into gases. In the reaction a great deal of heat is released. If you used small chips of wood, they would burn much faster because they present more surface to the air. And if you burned wood powder in an atmosphere of pure oxygen, combustion would be even more speedy. In fact, it would take place so fast that you would have a miniature explosion.

When you deal with regular explosives, you speed up the combustion still further, because chemicals are present which release oxygen and thus hasten the process. Most of these chemicals are compounds of nitrogen and oxygen, for nitrogen is a "lone wolf" element which separates readily from combination with others.

Hundreds of fast-burning, or explosive, compounds and mixtures are known, but only a few can be used as military explosives. These are the ones which remain inert until the proper moment and then give off their energy under a controlled impulse.

There are two basic types of military explosives. Those called propellants are relatively slow-burning and give off large quantities of gas. When one of these is exploded within the barrel of a gun, it builds up its pressure gradually and thus does not shatter the gun itself. Instead, it sets in motion the one part of the assembly that can be moved—the bullet or shell—and, as the gases expand, this is guided by the gun barrel and moves out to fly through space toward the enemy. Of course, the so-called slow burning of a propellant is slow only in comparison with the rapid detonation of a high explosive. Its burning actually occurs in a fraction of a second.

The second great class of military explosives consists of the bursting agents. These are insensitive explosives capable of withstanding the great heat and shock experienced within the shell when they are hurled out of the gun barrel. But when they finally do explode, the reaction takes place so fast that they shatter their steel containers and wreak havoc wherever they land.

While propellants explode by "burning," bursting agents explode by a process known as detonation. The difference is merely one of speed, but it is a great difference. Ordinary smokeless powder burns in the open air at a rate of three or four *inches* per second. Inside a gun barrel, heat and pres-

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A "SLOW" EXPLOSIVE HEAVES THE SHELL—



sure speed up this rate very greatly. But TNT detonates at a rate of over 22,000 *feet* per second, and nitroglycerin has a detonation speed of over *five miles* per second!

Both propellants and bursting agents, however, are relatively insensitive. This is an essential quality because otherwise they would frequently explode in the manufacturing plant, in shipment, or in an ammunition dump. But in order to cause them to go off at the proper time, ordnance experts have had to develop other explosives known as primers or detonators. These are sensitive enough to explode from the shock of a hammer blow or the percussion of a firing pin.

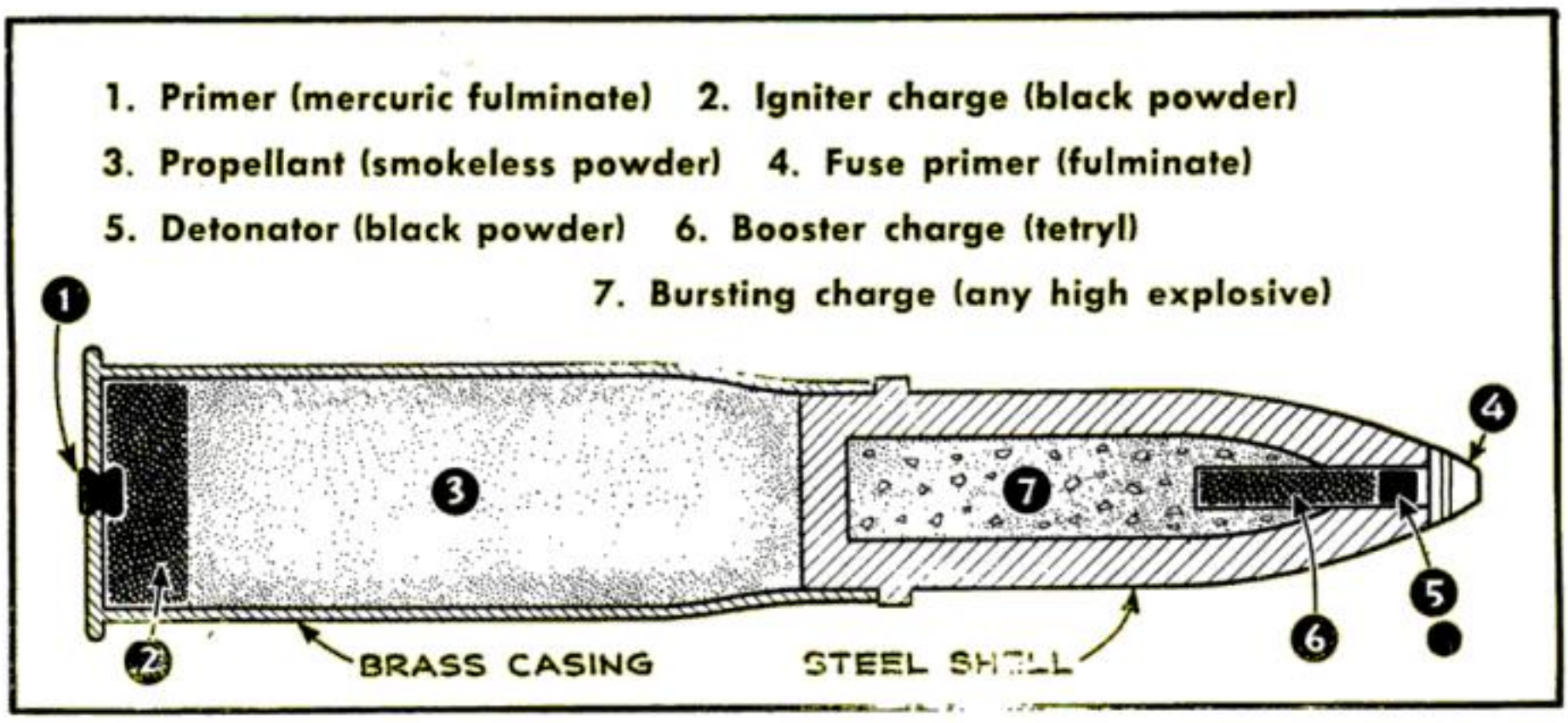
On small arms such as shotguns or rifles, a tiny detonator is sufficient to initiate the explosion of the smokeless powder in a shell. But in larger cannon, a chain of explosions frequently is necessary. The firing pin of a big gun will detonate a small and sensitive primer of fulminate of mercury. This will in turn ignite a charge of black powder, and this will pass on the explosion to the less sensitive smokeless powder that hurls the shell out of the gun and toward the enemy.

The same sort of train is used within the shell itself. With an armor-piercing shell, the artilleryman wants to be certain that the projectile first pierces the enemy's protective armor and explodes within the fortification or the hull of a ship. He accomplishes this by equipping his shell with a delayed-action fuse mechanism. The relatively insensitive explosives within the steel shell actually withstand the terrific shock of impact upon armor. But this shock slows up the shell, and causes a striker set in the back of the shell to hit a tiny detonating charge. This in turn may set off a booster charge and, completing the sequence, the booster will set off the high-explosive shell. Such a train of explosions can be designed to take any desired number of fractions of a second, or even seconds or minutes.

Even though propellants are relatively slow-burning, ordnance experts find it necessary to control their rate of burning. The ideal explosion is one which will continue with mounting force until the shell has left

EVERY BIG SHELL PACKS SEVEN EXPLOSIONS

Firing a big gun sets in motion a series of seven explosions, five of which are small, two of which are titanic. Detonated by the firing pin, a primer ignites a black-powder charge that, in turn, sets off the propellant—and causes the first big bang. On contact, the shell's fuse ignites the detonator, which sets off the tetryl. This booster sets off the high explosive to cause the last and biggest bang of all



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the gun. The pressure within the gun should build up gradually so as not to shatter the barrel; and none of the explosive should be wasted by failure to be consumed before the bullet has left the gun.

To control the burning of the propellant powder, it is formed into grains. The larger the caliber of the gun, the larger the grains of powder which are used. Increase in size slows up the burning, since the grains start burning on their outer surfaces and combustion progresses inward only as the outer layers are consumed.

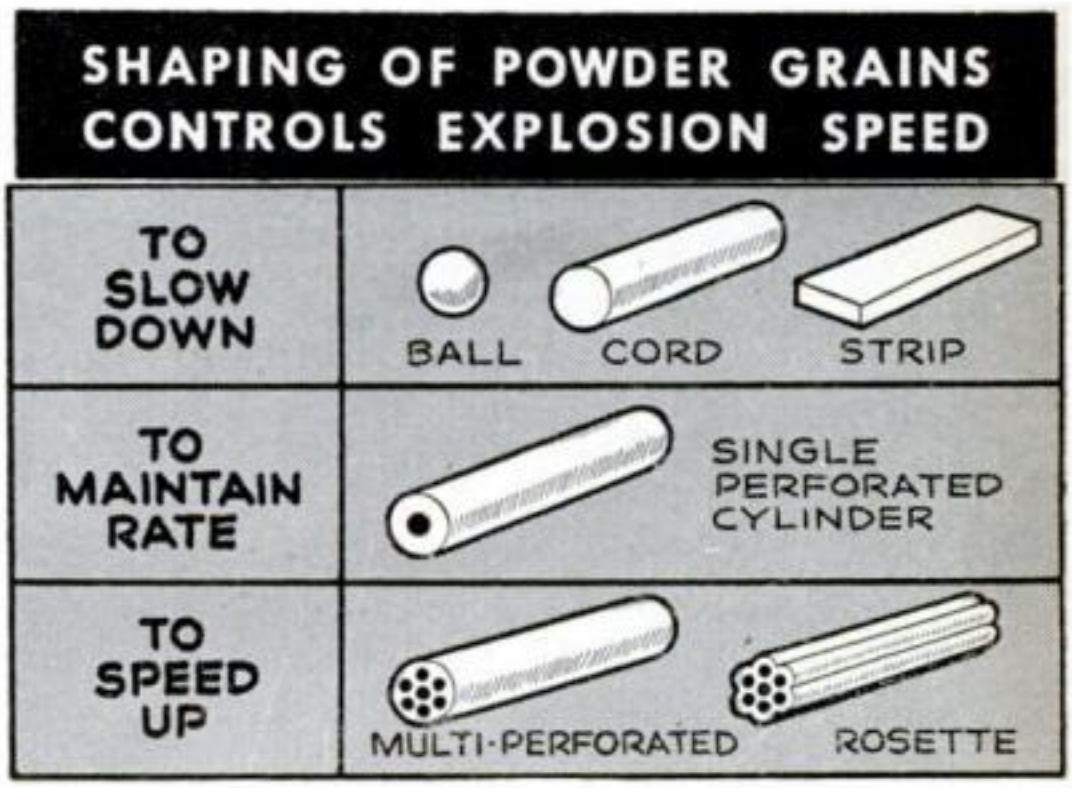
This method of slowing up burning presented the engineers with another problem. Originally, all grains were formed in spherical ball shape. Thus, they burnt fastest at the start of the explosion, when their outside surfaces had the greatest area. As each pellet burned away, it became a smaller sphere and thus produced its gases at a slower rate. Such round-grain pellets built up high initial pressures, which quickly dropped off. This didn't matter very much with small arms, but it was a serious drawback when large guns were involved.

To overcome this difficulty, ordnance experts have developed a number of different shapes for powder grains. The British evolved cordite, a smokeless powder in long, cordlike grains. The French developed thin, flat strips. In America, engineers worked out still another way of regulating the rate of burning. They continued using round pellets, but they coated them with relatively slow-burning outer surfaces. Thus, when the burning surface was greatest in area, at the beginning of the explosion, these deterrent coatings slowed down production of gases. Once the outer surfaces of the sphere were consumed, the faster-burning inner powder compensated for the reduction in the area of the burning surface. Such a powder grain would be termed "balanced," in that it produced its gases at a fairly uniform rate.

But American engineers have gone even further and developed "progressive-burning" powder grains—forms that increase their rate of burning as they are consumed. This is accomplished by forming the powder into cylinders with as many as seven holes running through a cylinder, parallel to its axis. While the outer surface of the cylinder decreases in area as it burns, the surfaces of the holes increase. Because they are designed to more than compensate for the decreased area of the outer surface, they actually produce gases at an accelerated speed toward the last quarter of their explosion.

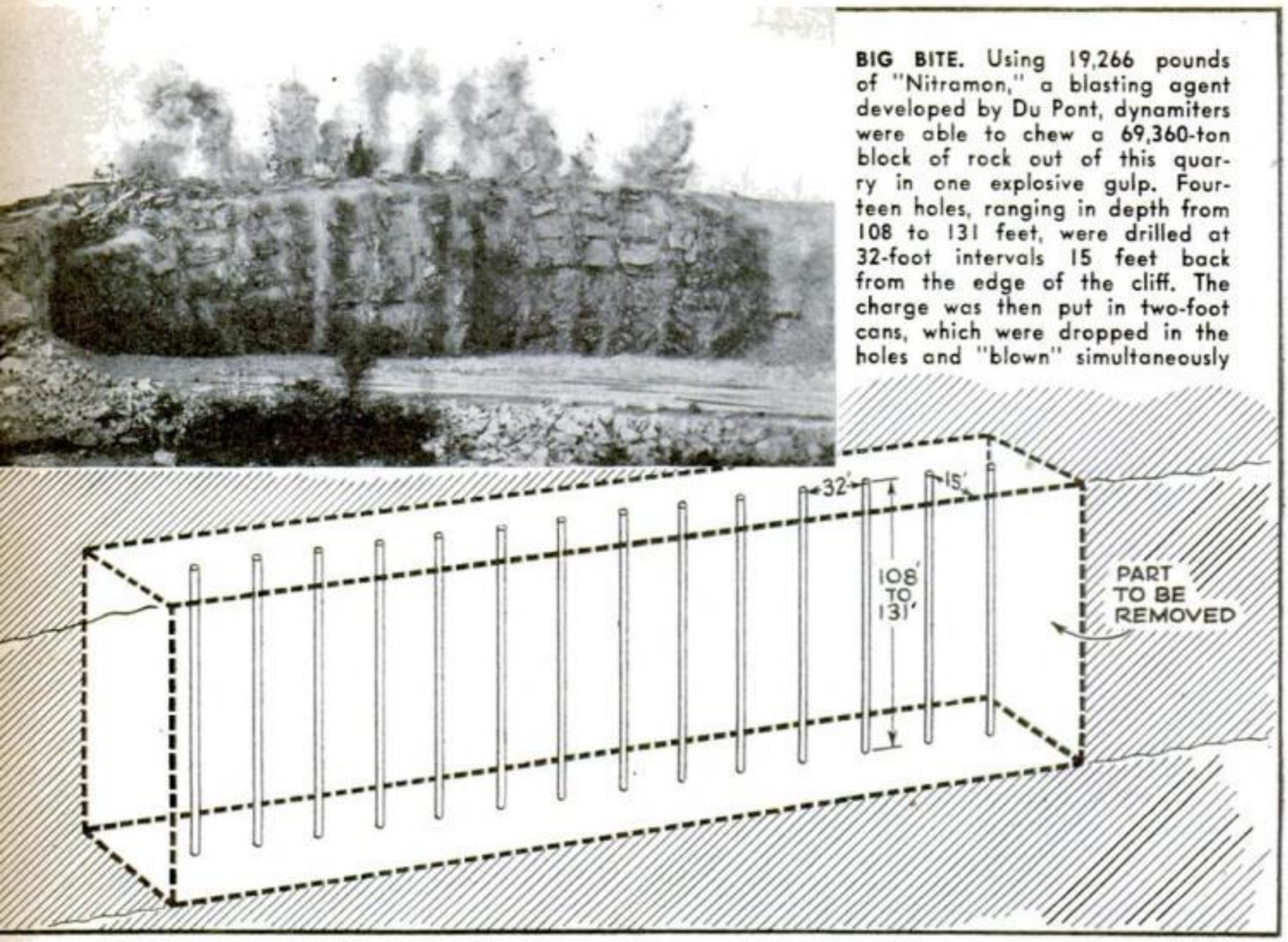
With such powders, it has become possible to design guns of high efficiency. Gun barrels can be thinner than before, and still withstand the pressures in the barrel, for these pressures build up gradually and the power of the explosion is not wasted in "flash" after the shell has left the gun.

American engineers were also responsible for the development of smokeless powders, although these were first adopted by other countries. Black powder, which had been



To reduce the rate at which a propellant builds up its gas pressure, its powder grains are shaped so that they lose in area as they burn, and consequently give off less and less gas. To maintain the rate, the grains are shaped into hollow cylinders so that the loss in their outer areas is exactly equalized by the increase in area within the cylinders. By adding perforations, surfaces can be made to increase as they burn. Gas production is thus tremendously accelerated

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BIG BITE. Using 19,266 pounds of "Nitramon," a blasting agent developed by Du Pont, dynamiters were able to chew a 69,360-ton block of rock out of this quarry in one explosive gulp. Fourteen holes, ranging in depth from 108 to 131 feet, were drilled at 32-foot intervals 15 feet back from the edge of the cliff. The charge was then put in two-foot cans, which were dropped in the holes and "blown" simultaneously

used from the earliest days until after the Spanish-American War, had a number of drawbacks, not the least of which was the fact that it gave off large quantities of smoke which aided the enemy in locating artillery.

Smokeless powders were made possible by the development, toward the end of the nineteenth century, of nitrocellulose. They are more stable, eliminating the greater part of the muzzle flash and smoke formerly associated with all firing pieces. However, they are not completely smokeless, although their small white puff is far less easily located than the dense black smoke of the powders formerly used.

Most armor-piercing shells depend upon steel rather than upon explosives to secure their armor-piercing effect. Such shells are made of extremely hard, tough, and heavy steel, hurled at great velocity from long-barreled guns. Large armor-piercing shells, such as those designed to penetrate battleship armor, are almost solid chunks of metal. The weight of their high-explosive charge can be only five or six percent of their total weight. Yet, that five or six percent is sufficient to cause terrific damage within the close confines of an armor-plated hull once the steel slug has penetrated.

Another method of armor piercing, which has not yet been adopted by any warring nation—except possibly in secrecy—involves the use of what is known as the Munroe effect. This phenomenon was first discovered by Charles E. Munroe, professor of chemistry at Columbian University, Washington, D. C., and was announced nearly 45 years ago in POPULAR SCIENCE MONTHLY.

Professor Munroe, in conducting his experiments at the Naval Torpedo Station in 1888, noted that explosive waves tended in certain cases to reinforce each other. His discovery was made quite by accident. Professor Munroe used to mark blocks of molded guncotton for identification by countersinking letters into the surface of the blocks. When such blocks were laid upon a steel plate and exploded, Dr. Munroe noted that after the guncotton had detonated, the letters were reproduced upon the iron plate.

What was most singular was that when the letters on the guncotton were raised above the surface they also came out raised on the iron plate.

"In experimental investigation," Dr. Mun-

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roe wrote in POPULAR SCIENCE, "I eventually bored holes of various diameters and depths in guncotton cylinders and in the last instance, I bored a vertical hole completely through the cylinder. These cylinders were each placed on a similar iron plate. When they were successively fired, it was found that the deeper and wider the hole in the guncotton was, the deeper and wider were the holes produced in the iron plate. When the completely perforated guncotton cylinder was fired, the iron plate was found to be completely perforated."

What Munroe had done was to shape an explosive charge in such a way as to cause the detonation waves to reinforce each other. He concentrated much of the explosive force in one direction, parallel to the axis of the cylinder.

Conceivably, such shaped charges might be used for armor-piercing purposes on large shells, eliminating the necessity of sacrificing ninety percent or more of an armor-piercing shell to the weight of steel. A shaped-charge shell would be almost entirely made up of explosives, with only a thin outer container of metal. Gunners using such a shell could deliver a far greater quantity of explosives to a point of impact.

So-called industrial explosives—of which dynamite is the best known and most widely used—play an important part in the winning of the war, both by making production possible at home and in their application on and immediately behind the battlefields. Dozens of new and improved methods of using such explosives have arisen directly out of the war effort.

Dynamites have changed greatly from the first product developed by the great Alfred Nobel. Nobel made dynamite by absorbing highly explosive nitroglycerin in an inert earth called kieselguhr. This made a powerful explosive which was still sufficiently insensitive to shock to permit its being transported and stored without great danger.

Today, instead of kieselguhr, dynamite makers use mixtures of wood pulp, nitrate of soda, nitrate of ammonia, and other compounds to absorb the basic nitroglycerin. By varying these materials, they can control both the sensitivity and the power of their dynamite and, at the same time, control fumes which will remain after detonation. Such control is very important in preventing accidents in underground mining.

Gelatin dynamites, containing nitrocotton dissolved in the nitroglycerin, are highly water-resistant and can therefore be used for underwater blasting. In the old days, many accidents were caused by attempting to thaw frozen dynamite at open fires. Today, antifreeze chemicals are mixed into dynamite to eliminate this problem.



U. S. Bureau of Mines

MINERS save a lot of time and energy with dynamite. By using different absorbing agents, experts can make "nitro" less touchy, and can also reduce its detonation fumes—a vital problem in underground blasting



"BIG INCH." To blast a trench for an underwater section of this famous pipe line, Du Pont technicians dropped 16,000 pounds of dynamite into holes drilled into the bottom of Pennsylvania's Susquehanna River

OIL PROSPECTORS are putting dynamite to a new use by detonating a charge to set up miniature earth tremors for seismic recording. A study of the vibrations shows if the ground is favorable for drilling

Hercules Powder Co.







FURNITURE specially constructed to conserve war-important woods and metals is shown in the photographs above. The chair at the left makes use of discarded webbing that was originally woven for use in Army gun slings and parachute straps. Palm leaves and Mexican mesquite furnished material with which ingenious furniture designers fashioned the attractive chair and rocker pictured at the right.



HOME OWNERS

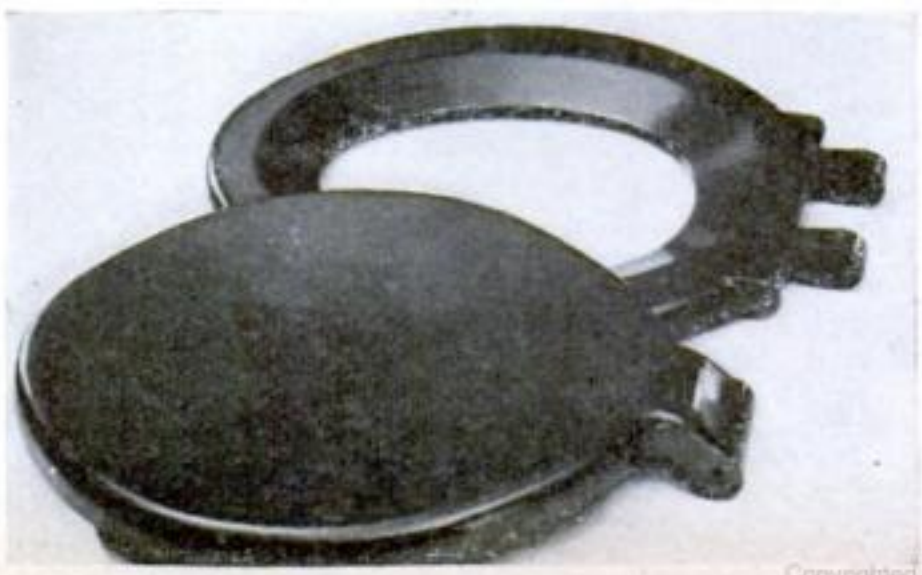


CLOTH WON'T BURN after being dipped in a solution which makes it fire-resistant. One use of this rinse is to safeguard welders whose overalls are apt to catch fire from flying sparks. It also has many home uses. Curtains which may blow against lighted candles; sheets, slip covers, table linen, which are likely to get cigarette burns; and clothes worn when doing home dry cleaning can be made fire-resistant by treating them each time they are washed.



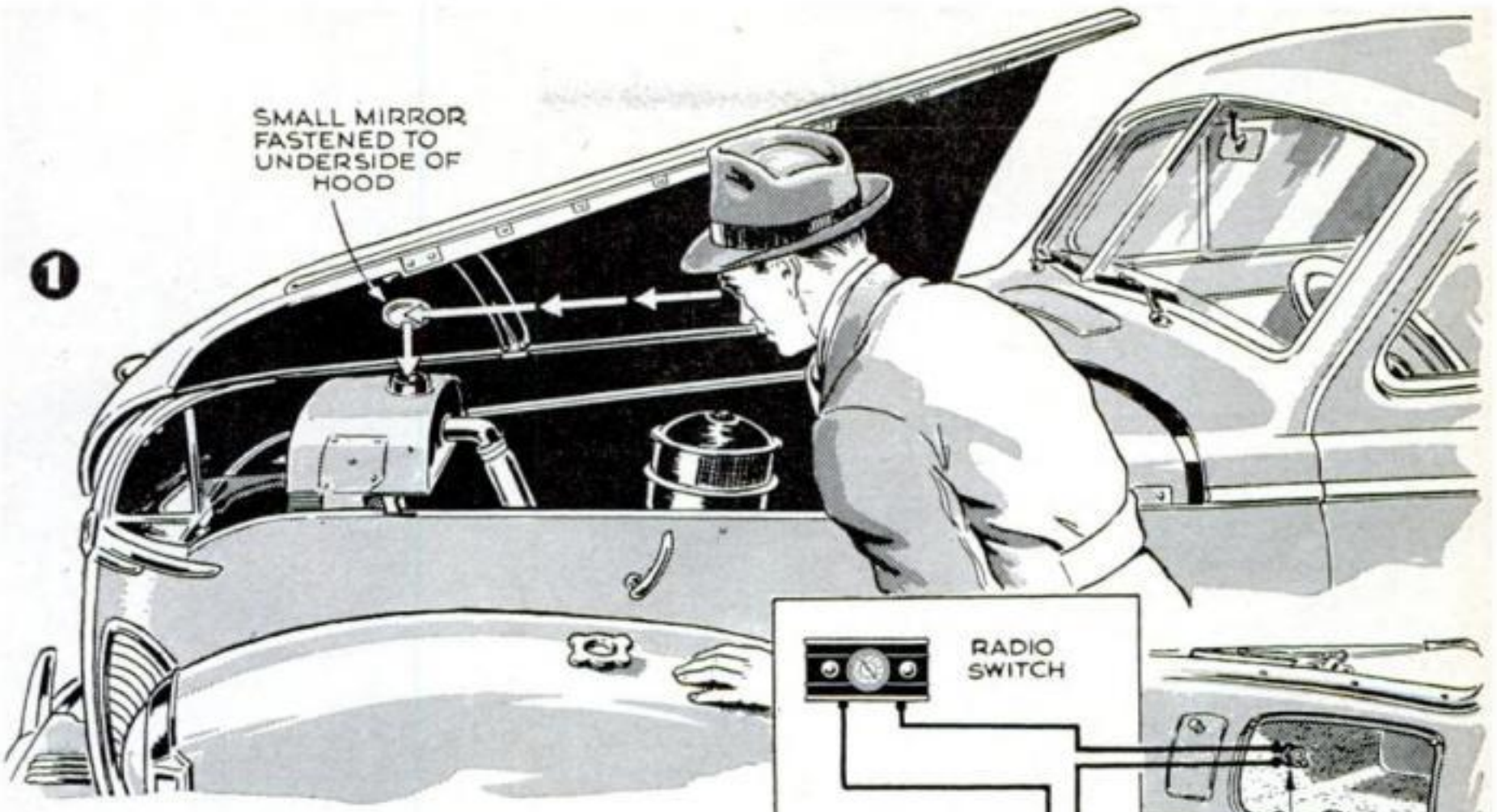
CLOSETS ARE CEDARIZED with a new powder giving off a pungent vapor that repels moths. This closet air conditioner, made of cedar-leaf oil, is also said to absorb moisture from the air and protect clothes from mildew. Articles within the closet carry away a pleasing fragrance.

PLASTIC TOILET SEATS of hygienic design are among the priority goods that will be available for the postwar home. Molded in one piece, and having a smooth finish that requires no varnish or paint, they are easy to clean and will withstand repeated sterilizing. The seats are available in either black or brown, and the manufacturers say they should last a lifetime.

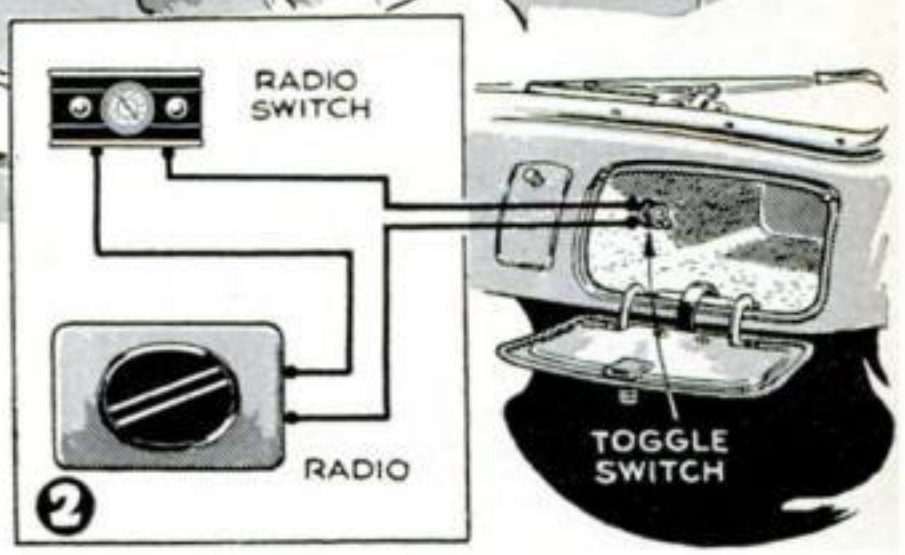


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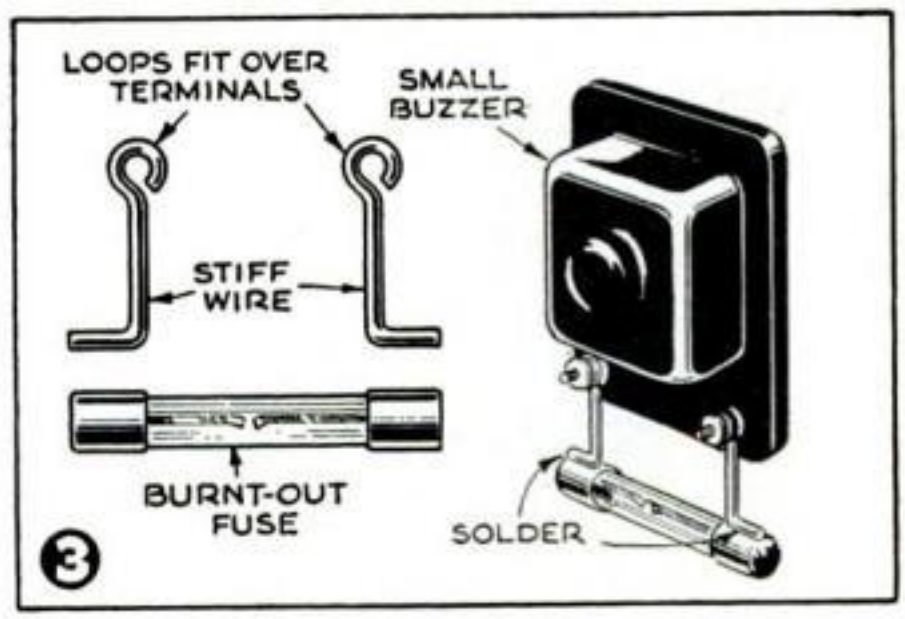
USEFUL AUTO HINTS



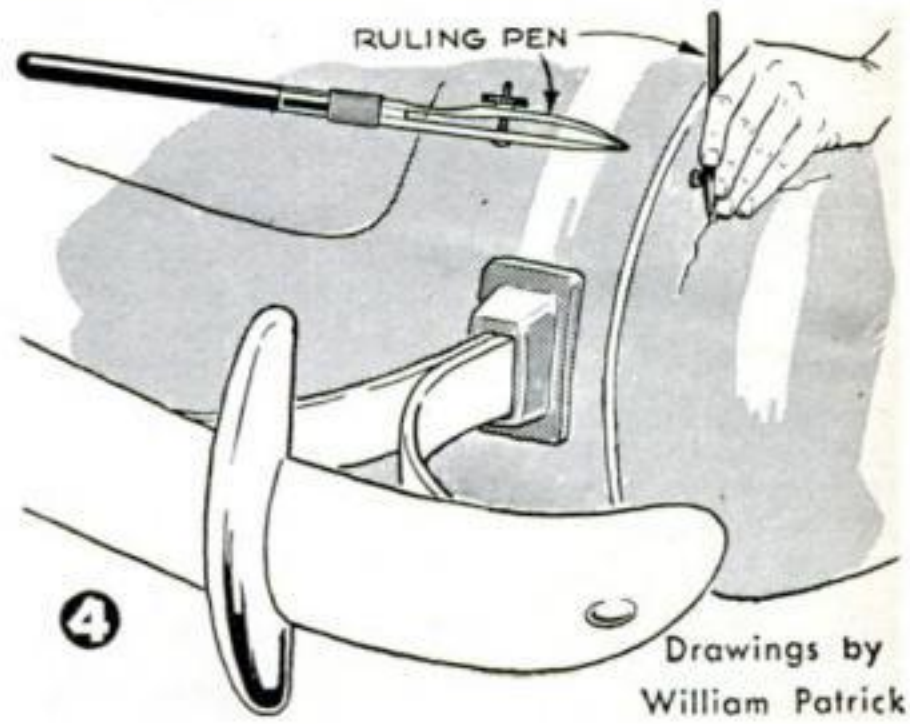
1 **RADIATOR FILLING CAPS** in many recent-model cars are located in such a position that it is difficult to check on water level without head-bumping or gymnastics. If a small mirror is cemented to the underside of the hood or bolted to a brace, the liquid level can be easily seen.—W. E. B.



2 **A SECRET RADIO SWITCH** will prove handy in circumstances where a car must be left unlocked, as in many parking lots or garages. A toggle switch, wired in series with the regular radio switch and installed in the glove compartment (which in most cars can be locked), will help prevent this annoying battery drain.—R. W.



3 **HUNTING DOWN SHORT CIRCUITS** in auto wiring is simplified by this device. It consists of a small 6-volt buzzer, mounted as shown on a burnt-out fuse. When a regular fuse blows, replace it with this test rig, which will give an audible signal to indicate the short. An interruption of the sound means that the short is temporarily removed. Listen also for changes in pitch of the buzzer, since they may signal removal of the short with continuing flow of the current through a headlight or other load.—R. K.



4 **TOUCHING UP SCRATCHES** on a car fender or body is easily and inconspicuously done with a ruling pen of the type used by draftsmen. It can be adjusted quickly to the required width, and it tends to follow the groove of a scratch, thereby contributing toward a neat job.—H. F. R.

Drawings by William Patrick

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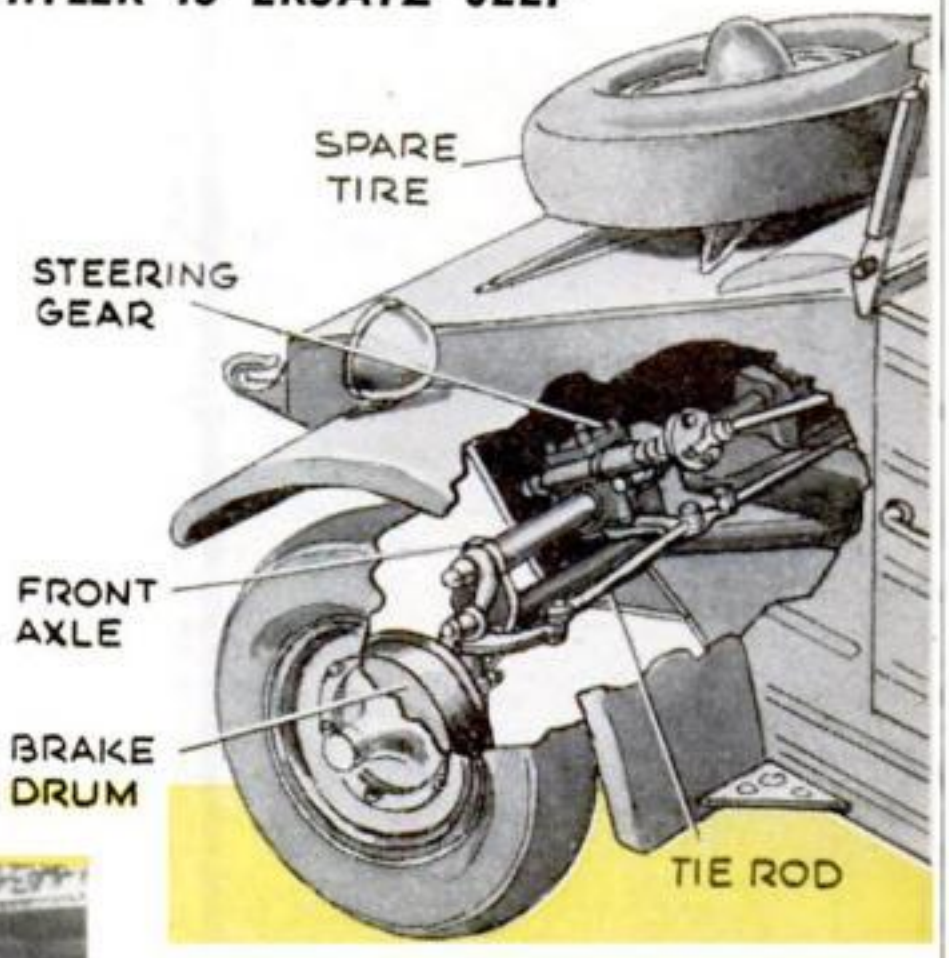
END OF ANOTHER NAZI DREAM . . .

THIS WAS GERMANY'S FLIVVER

"PEOPLE'S CAR" PROMISED BY HITLER IS ERSATZ JEEP

BACK in the thirties, when Germany's war preparations were weighing heavily on her people, Nazi leaders dangled before the public a vision of a wonderful "poor man's car" soon to pour from the factories. It was to be an automotive marvel, light, fast, roomy, and inexpensive; and it would reward Germans for the low wages, long hours, and shortages.

Never made in quantity for civilians, this *Volkswagen* has turned up on battlefields as an inferior version of our jeep. Captured models, tested and taken apart by U. S. experts, show that the car is less rugged and versatile than its American prototype, but ingenious in design and economical to run. Power is supplied by a four-cylinder opposed motor, mounted at the rear and driving the rear wheels. The engine develops some 24 hp. and is cooled by a blower and housing that delivers air to the cylinders. Top speed is above 60 m.p.h., while gasoline mileage at this speed is about 33 miles per gallon. The fuel tank, mounted in front of the dash, holds six gallons. A steel backbone replaces the conventional chassis, and springing is accomplished by means of coil springs located within transverse, pipelike housings.



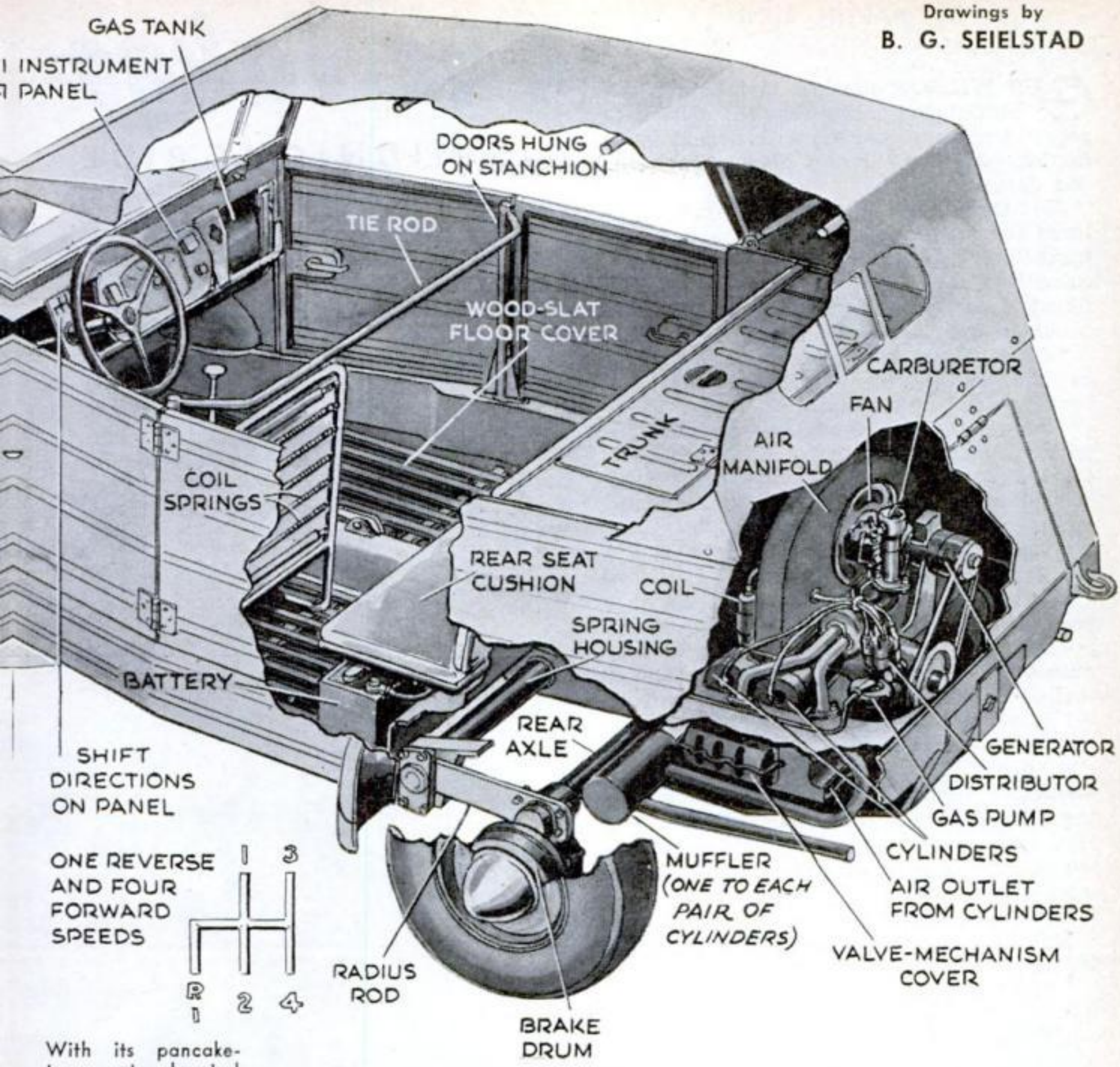


A civilian model of the car, shown above, was publicized by the Nazis as within reach of practically every worker's pocketbook. But the promised mass production was put off

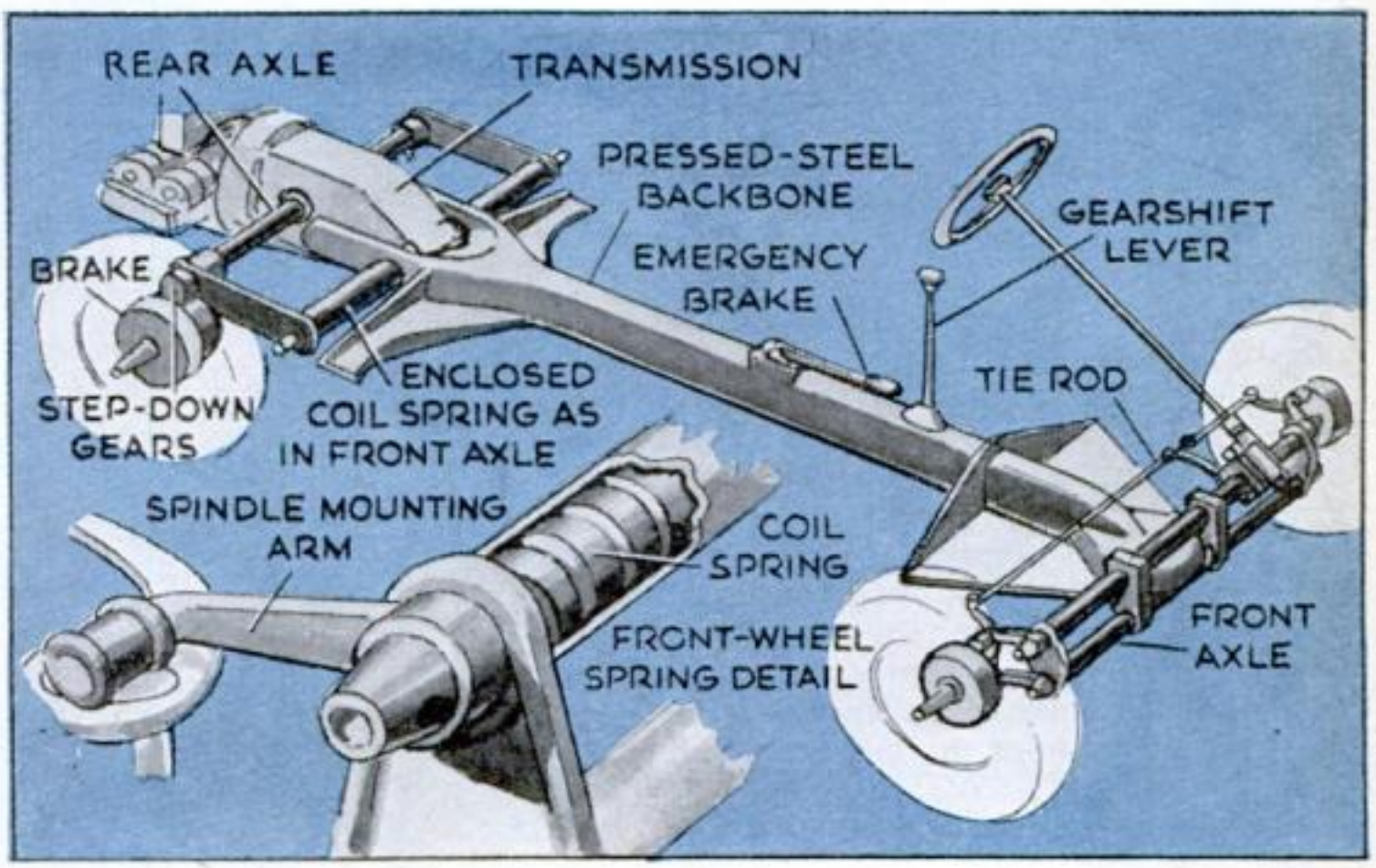


Converted for military uses, the Nazi flivver serves the Germans as a light general-purpose vehicle. This one was captured in Africa and brought to this country for testing. It hasn't the four-wheel drive or ruggedness of our own justly famous jeep

Drawings by
B. G. SEIELSTAD



With its pancake-type motor located in back of the rear axle, the car has ample stowage space in front. Note that radius arms from rear axle give spring play and transmit start-and-stop thrust



A single steel member down the middle forms the chassis. Controls for transmission and brake run through the backbone. Reduction gears are placed beside each rear wheel

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By MARTIN BUNN

Gus Takes
HIS MIDNIGHT RIDE

GUS WILSON finished installing a reconditioned carburetor, stood back to regard the completed job with honest satisfaction, and decided he'd done enough for one day.

Just then the roar of a motorcycle shattered the night. Gus looked up, and a moment later State Trooper Jerry Corcoran came into the Model Garage, his browned face serious under his rakishly tilted, wide-brimmed felt hat.

"I'm checking on a truck that's missing," he said, and jerked a notebook out of the breast pocket of his tunic. "Name of W. & W. Manufacturing Company, Middletown, painted on it. Driver name of Joe Pickett, 40, five foot 10, dark hair, dark eyes, clean shaved, wearing a windbreaker, work pants, and a cap. Has he been in here?"

"Nope," Gus told him. "What's it all about, Jerry?"

Corcoran replaced his notebook, fished a pack of cigarettes out of his other breast pocket, and lighted one. "This Joe Pickett pulled out of Middletown about four o'clock this afternoon with a half-dozen cases of W. & W. radar—or something even more hush-hush—to be delivered at a pier in the city to a ship sailing at midnight," he explained. "When he hadn't showed up at 11, the Army got worried and sent out an alarm. He's been traced as far as this county—stopped for gas about nine o'clock. That puts it up to us."

Then Jerry roared away.

Fifteen minutes later, as Gus was washing up, the phone rang.

Jerry Corcoran's voice snapped over the wire: "I've located that truck, Gus, and you're the man to help me out. It's stalled a mile in on the dirt road from the highway to Springdale."

"I know the road," Gus said. "But what the dickens was it doing there?"

"That's what *I'd* like to know," Jerry said grimly. "The driver says someone told him it was a short cut. There's something fishy about the guy, Gus. Come and give me a hand."

"O.K.," Gus said. "I'll be there in 20 minutes."

As he turned off the highway into the dirt road, his headlights knifed into pitch blackness, and a mile farther a flashlight flagged him down.

"It's me, Gus," Jerry Corcoran said. "The truck's down the road, but I want to talk to you. I'm sure this guy Pickett is lying. He says his motor began to miss and then went dead, and that he spent an hour checking the gas line without finding anything. Now he's back there fooling with the ignition."

"Well," Gus said, "we'll soon find out."

Fifty yards farther on, Gus's headlights picked up a truck at the side of the road. A man, who had had his head under the hood, looked up.

"I've found the trouble," the fellow said. "The condenser's burned out." He pointed at something lying on the running board.

"Bring your flashlight," Gus said to Jerry.

They went over to the truck, and the trooper flashed the beam on the running board. A condenser case was lying there. Beside it was the condenser, its series of



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Over for Paul Revere

SPEEDS A CONVOY AND FOILS A SABOTEUR

alternate sheets of tinfoil and insulation roughly pried apart in several places. Gus examined it carefully. Then he turned to the driver.

"You're lying," he said sharply. "This condenser wasn't burned out; it was deliberately ruined."

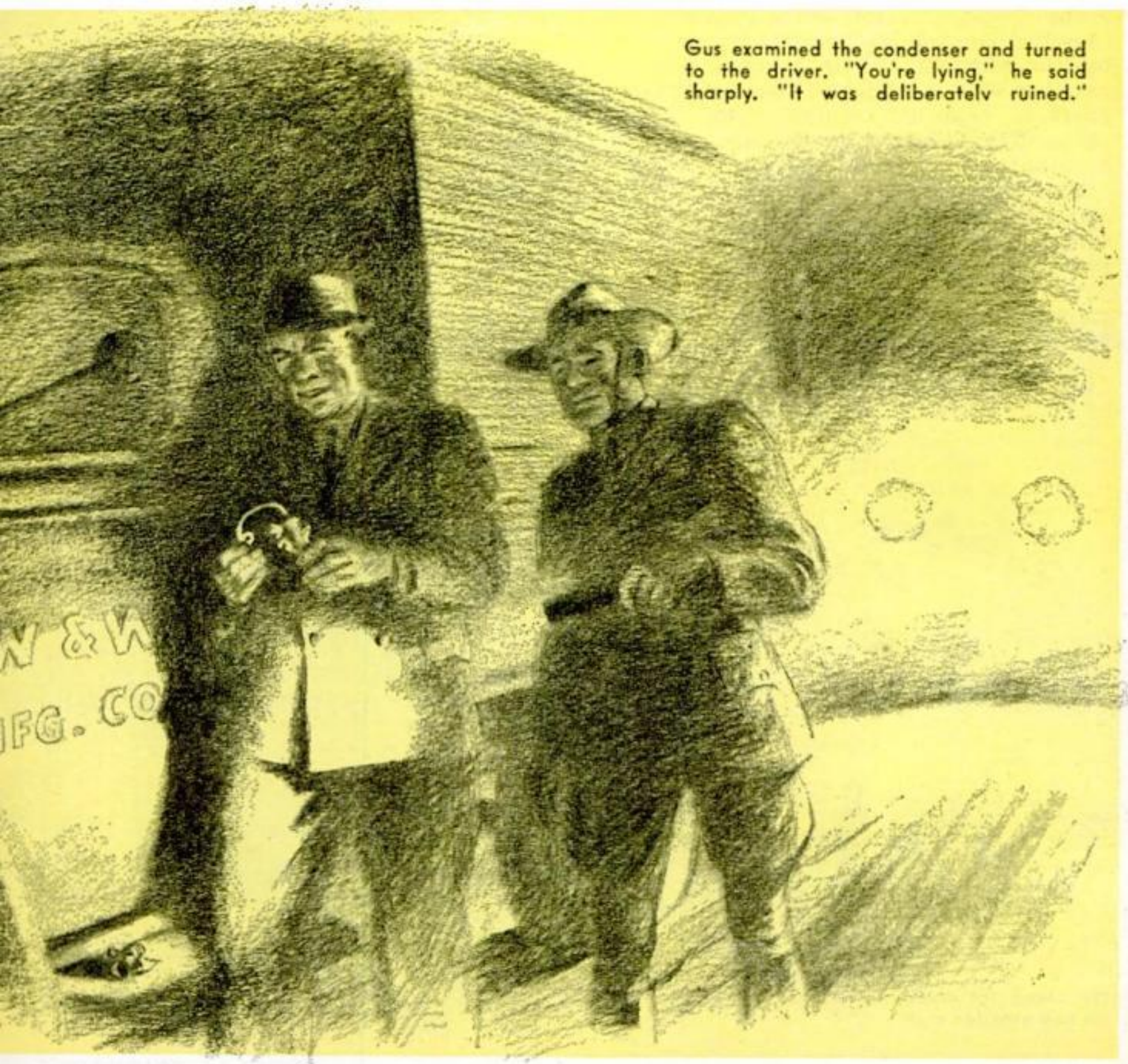
"I wanted to see what was the matter with it—I thought I could fix it," the man muttered.

"That's another lie," Gus snapped. "Anyone who knows enough about automobile ignition systems to locate condenser trouble and dismount the condenser, also knows that taking a condenser apart ruins it. You've stalled this truck purposely."

"That's right," Jerry cut in. "You're under arrest, Joe Pickett. You're going to get a chance to tell the G-men just why you've held up an Army rush shipment." He turned to Gus. "How are we going to get this truck going?"

Gus scratched his head. "Going to the shop for a new condenser will take too much time," he said. "I might take the one out of my car, but that would leave me stalled."

Then after a pause, "I've got it," he said. "If I can find—"



Gus examined the condenser and turned to the driver. "You're lying," he said sharply. "It was deliberately ruined."

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He pointed the flashlight into the truck, then reached in and pulled out two foot-long two-by-fours that obviously had been used as wedges for packing cases.

"You take off the front license plate," he told Jerry, handing him a screwdriver and a pair of pliers, "while I take off the rear one."

"What for?" Jerry wanted to know.

"Never mind what for," Gus told him. "Step on it!"

"O.K.," Jerry said. "This job is your baby now." He turned to the driver. "You get in the truck and stay there," he ordered.

Gus took off the rear license plate. A moment later Jerry brought him the front plate.

"Let's have your handkerchief," Gus said. Jerry handed his handkerchief over.

Working in the beam of his roadster's headlights, Gus put one of the two-by-fours on the ground, placed a license plate on it, folded the handkerchief and put it over the license plate, laid the other license plate over the handkerchief, put the second two-by-four over that, and tied them all securely together with a length of twine. With his pliers he bent the corners of the license plates so that they were well apart, and then scraped the paint from around the bolt holes.

Then he took the contraption to the truck, and using the bolt holes in the plates to attach the wires, installed it in place of the ruined condenser.

"Switch on your ignition and step on the starter," he called to the driver. A moment later the engine was running.

"That'll hold," Gus told Jerry. "You'll have to drive my car."

"O.K.," Jerry said. He wheeled his motorcycle over and lifted it into the truck. Then he said to the driver: "You're riding with me, Mr. Saboteur."

Pickett climbed out of the truck looking frightened. "You guys got me wrong," he protested through a wad of gum. "I ain't any saboteur. I'm just sick of being pushed around and overworked."

"Stow it," Jerry cut in sarcastically. "The G-men may want to hear it."

They stopped at the State Police station. Jerry turned Pickett over to the sergeant and did some telephoning. Then he came out and got his motorcycle out of the truck. Near the city line an approaching jeep made a U-turn and swung in ahead of them.

"O.K.," an officer called to Jerry. "We'll take him the rest of the way."

Jerry waved his hand and swung over to the side of the road. Gus followed the jeep.

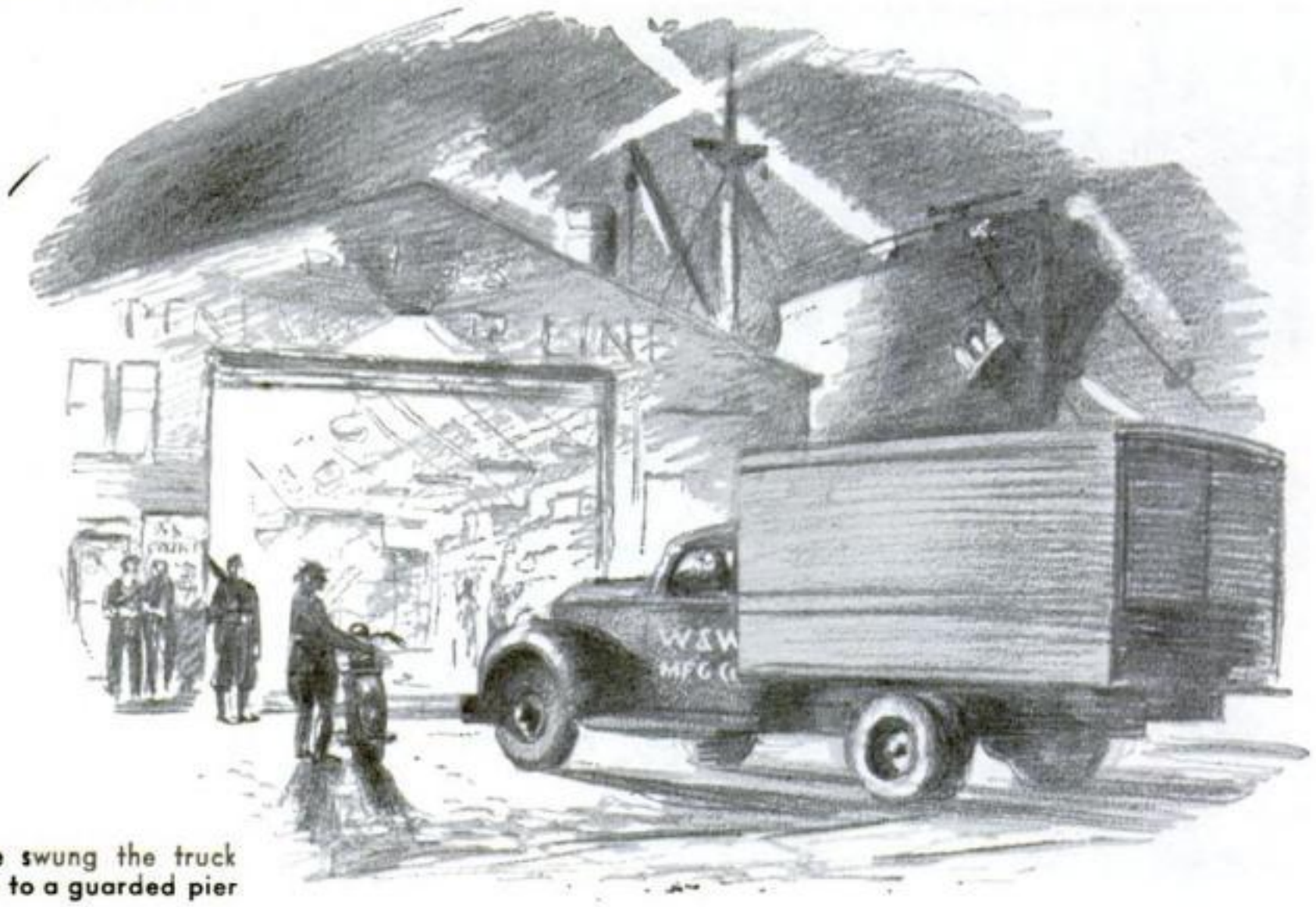
Twenty minutes later Gus swung the truck on to a guarded pier. Husky soldiers manhandled its load up a gangplank of a cargo ship. As soon as the last box was aboard, the dark ship slipped quietly away.

Some time later Jerry Corcoran answered the station-house phone. It was Gus Wilson.

"Get home all right?" Jerry asked.

"No, I didn't get home all right," Gus snapped. "I'm in the city jug for driving without tags. What are you going to do about it?"

Jerry laughed. "Put the sergeant on the wire!" he demanded.



He swung the truck on to a guarded pier

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RING TROUBLES and How to Cure Them

By RALPH ROGERS

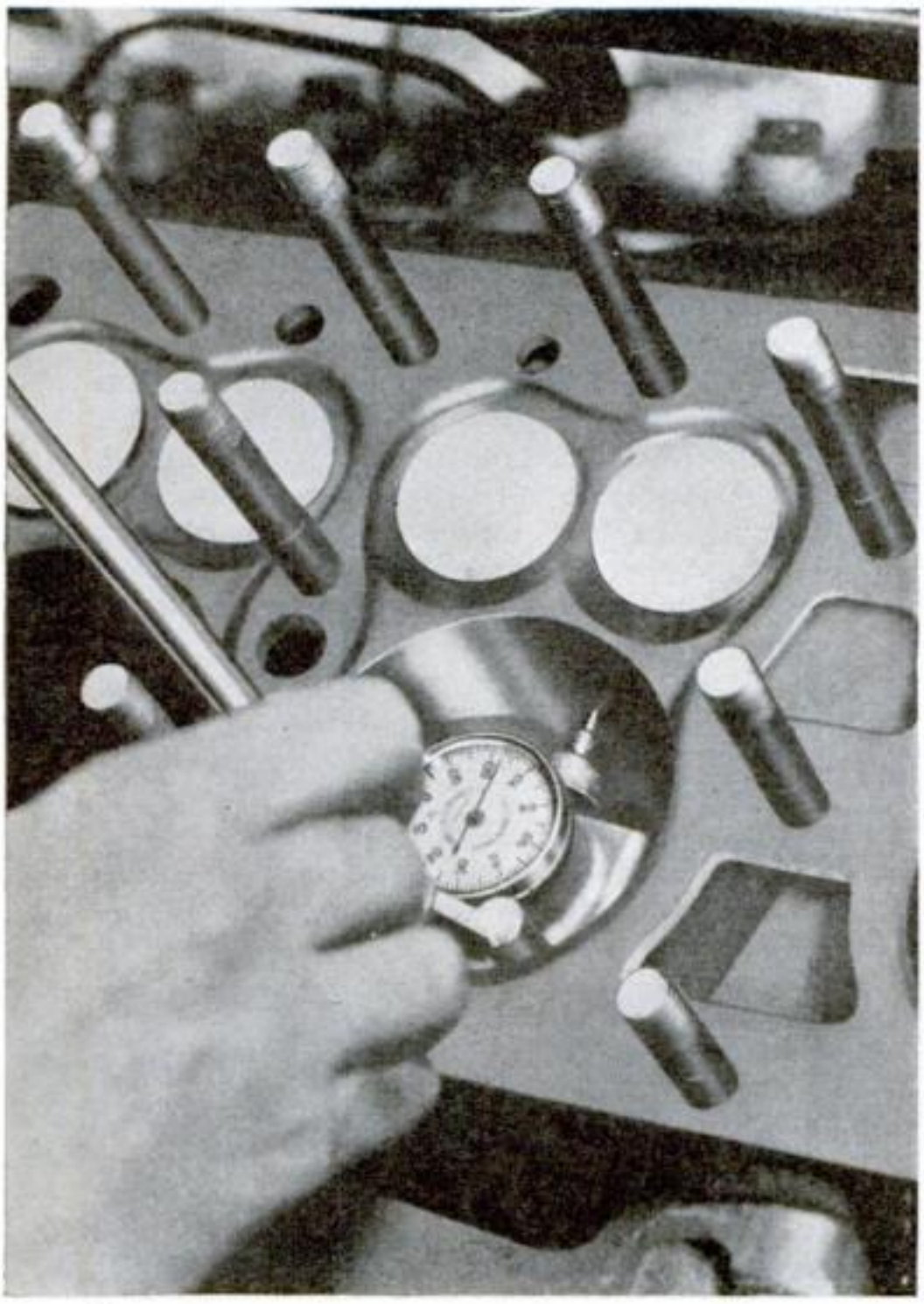
PISTON rings, tailor made by the manufacturers to individual engine design, are precision parts of the modern automobile. They serve to fill up or seal the clearance between a piston and cylinder wall, keep blow-by or burned gases from escaping into the crankcase during the power stroke, and regulate the flow of oil to the walls of the cylinders.

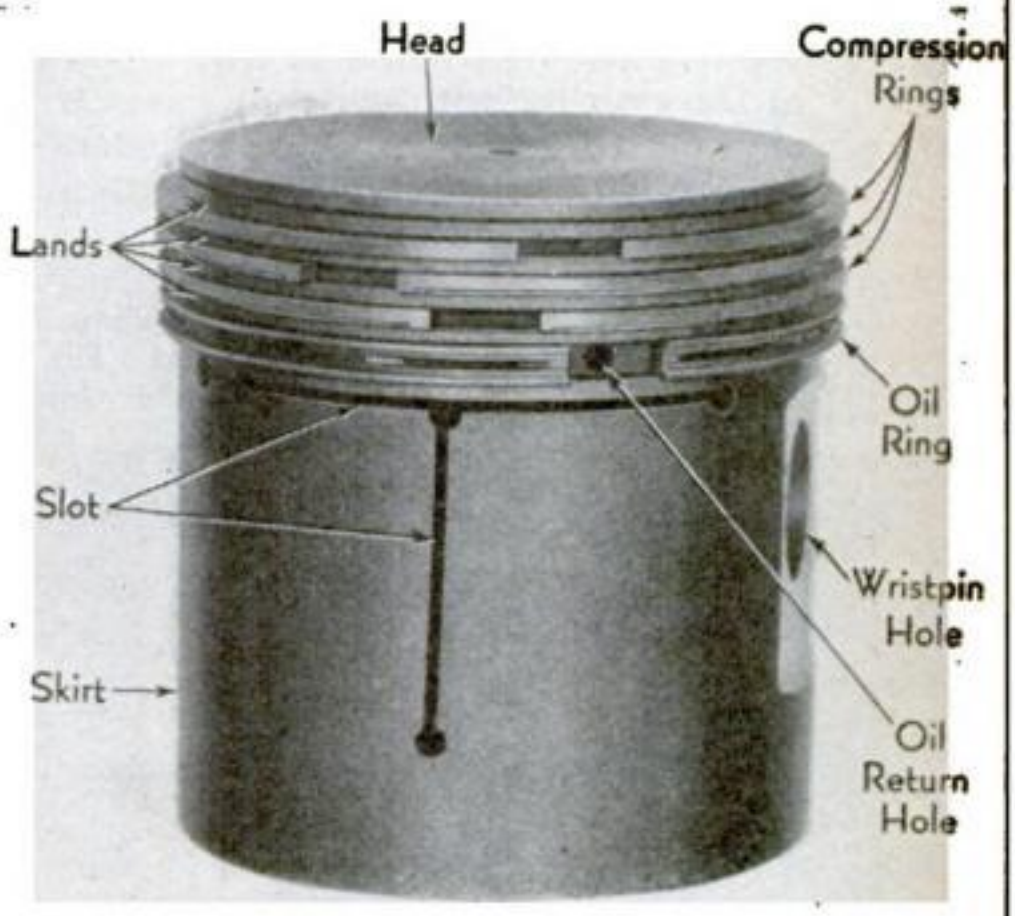
Just why a piston ring must be a precision part may be seen from the figures of one maker who has calculated that the average automobile engine burns three one-thousandths of a drop of oil per explosion. If it burned as much as a tenth of a drop, it would use 90 quarts of oil on a 600-mile trip traveled at 60 m.p.h.

However, there are other parts of a motor that help control oil consumption, so don't jump to conclusions if it seems excessive. Too often an extreme ring setup is installed when it isn't needed with the result that the upper part of the cylinders runs dry and wear and failure are rapid.

Look first for external oil leaks at the valve cover, fuel pump, and oil-pan gaskets; then see that oil lines, pipe plugs, front and rear main-bearing seals, and the crankcase ventilator are not leaking. A thorough inspection can best be made by wiping these parts clean and road-testing the car at various speeds, after each of which an examination should be made for signs of fresh leakage.

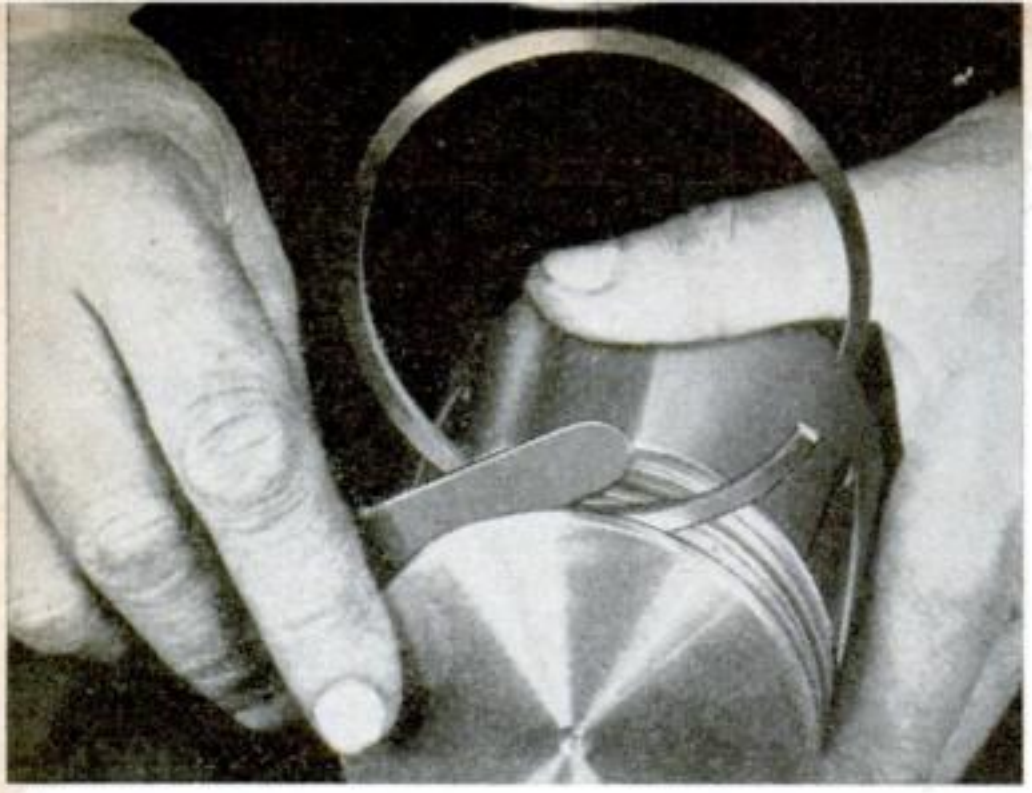
Many cars are equipped with combination fuel and vacuum pumps, the vacuum section being used for the operation of windshield wipers and other accessories. A leaky diaphragm will suck oil from the crankcase into the vacuum line from where it will enter the intake manifold and combustion chamber and produce a blue smoke at the exhaust. Watch for sluggish action of the windshield wipers





CHECKING THE CYLINDER BORE will show whether honing is advisable. Here a dial gauge is used. Right, a typical piston with its parts named

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SIDE CLEARANCE must be allowed between a new ring and the groove. Measure with a feeler gauge and, if insufficient, lap both sides of the ring on fine emery cloth placed on a flat surface



RINGS ARE INSTALLED or removed with a ring tool or pliers, opening the ends to expand them. Stagger gaps of new rings, except on a Hudson, but put no gap over a wrist-pin hole

during acceleration as an indication of a defective diaphragm.

Two other points should be exam ed before concluding that the piston rings are at fault. If the intake-valve guide clearances are excessive, replace the guides (see P.S.M., Apr. 1944, p. 136); if the guides are all right, check the engine bearings (see P.S.M., Aug. 1943, p. 128). An average safe clearance for intake-valve guides is .002" to .003", while that between the crankshaft and bearings is .002" to .0025". The manufacturer's directions should be followed if available.

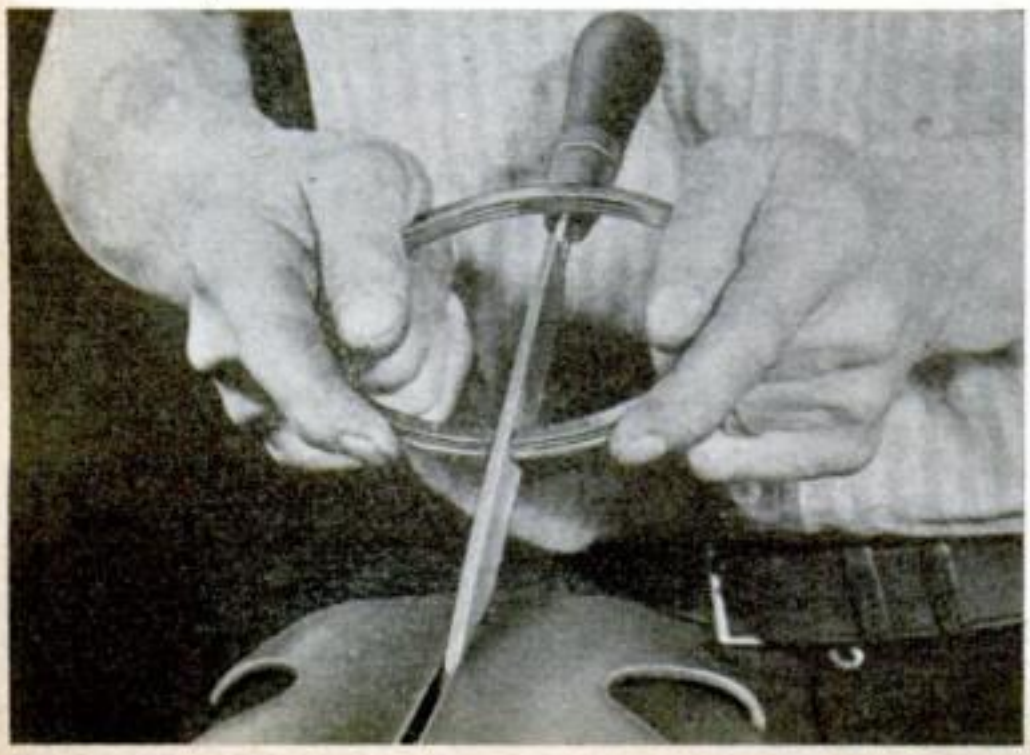
Pistons on all present-day cars are removed through the top of the cylinders, which means that the cylinder head will have to be taken off. In doing a piston job, there are some important precautions to take. After removing the oil pan and cylinder head, but before taking off the connecting-rod caps, examine each cap to see whether it is stamped with the number of the cylinder with which it goes. If there are no markings, number the cylinders yourself on *both the rods and caps* with a sharp punch and a hammer, noting on which side of the engine you place the markings.

Now, before attempting to remove the piston, ream the top of the cylinder bore where a ridge has been formed at the end of the ring travel and thus avoid the possibility of breaking the second ring land and ruining the piston. Use a special ridge reamer, and do not cut down further into the ring-travel area than 1/32" or half the width of the top ring.

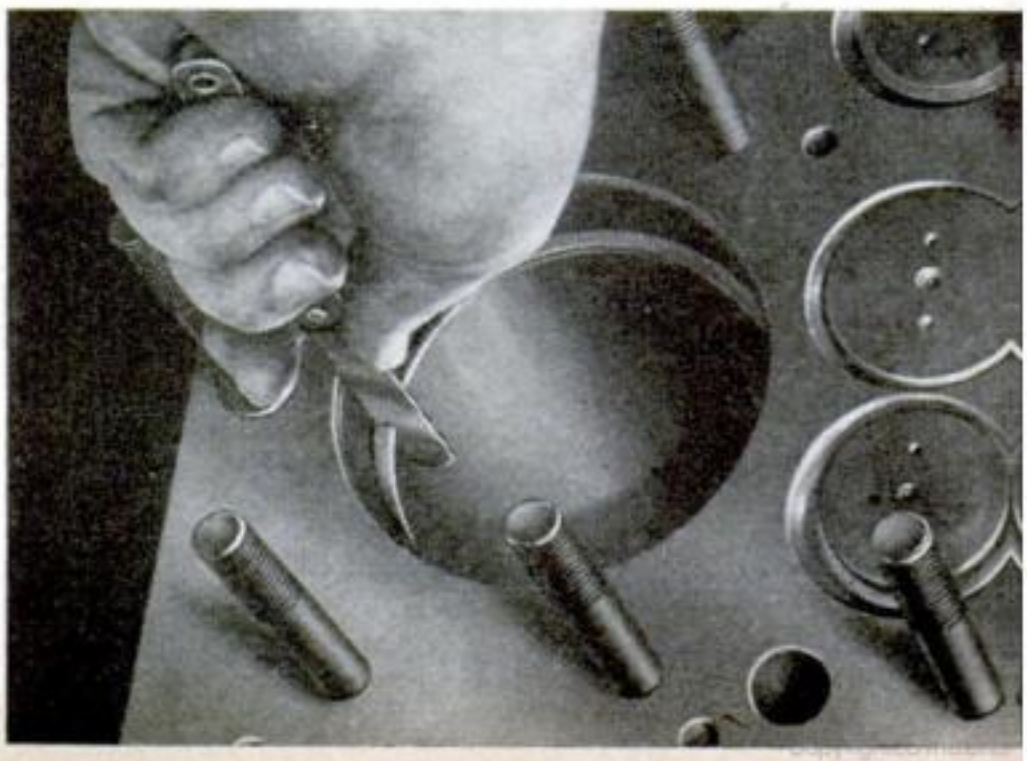
Examine the piston assembly after removing it to see how the rod is attached. In most modern engines, which have a force-feed lubrication system and aluminum pistons, the rod is assembled on the piston with the oil-spurt hole facing the camshaft and the slotted side of the piston facing the other side of the engine. Cast-iron pistons do not have slots, and rods in splash-lubrication systems do not have oil-spurt holes.

Next, check the cylinder bores for wear, taper, and out-of-round, using a dial gauge, an inside micrometer, or a telescope gauge and an outside micrometer. Take measure-

END GAP IS INCREASED by filing lightly. The ring below has a butt joint. File both ends of a ring with a step cut or lap joint



TEST THE RING in the bore, pushing it down with the piston to be sure it isn't cocked. Insufficient end gap will cause heat to buckle it



ments within the ring-travel area near the top and bottom. If the bore is worn more than .003″ per inch of cylinder diameter, a full honing or reboring job is advisable and should be done at a shop having the equipment. For example, if the standard diameter of the cylinder is 3″, and the wear is .010″, a rebore job is indicated. New pistons, of course, will also have to be fitted. They are usually available in oversizes of .010″, .020″, .030″, and larger.

When new rings are to be installed, the old ones must be removed carefully to avoid scarring the piston. One method is to expand the ring with thin-nose, outward-opening pliers, slipping a thin strip of metal between the ring and piston and working it around to the far side; then expand the ring a little further and work in a second and third strip, after which the ring can be slipped off. Take off the top ring first, and in installing new ones, put on the lowest first and work with the same thin metal strips. If special instructions are provided with the new rings, they should be followed. Be sure also to clean the grooves, taking care not to score the metal.

New rings sometimes have to be lapped slightly to allow proper side clearance in the ring grooves, and the ends may have to be filed to obtain the proper end gap. If the specifications of the car manufacturer are not available, it is safe to allow a minimum end gap of .003″ per inch of cylinder diameter, that is, .009″ for a 3″ bore. Minimum side clearance for aluminum pistons should be .0015″ to .002″ in the top groove and .001″ to .0015″ in the lower grooves; for cast-iron pistons, .002″ to .0025″ in the top groove and .0015″ to .002″ in the others. Do not allow excessive side clearance, for it may cause excessive oil consumption.

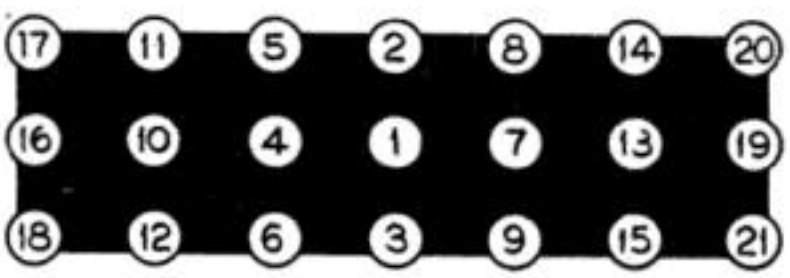
The sides of a ring may be lapped on a piece of plate glass, using a fine lapping compound and rubbing gently with a circular motion on one side and then the other. One photo shows a method of filing ends.

Do not force or drive a piston when returning it to its cylinder. The new rings will have to be compressed sufficiently for them to enter the bore. This can be done either with strong cord or with a sleevelike device that closes the rings as they enter.

When retightening the connecting-rod bolts, use a torque-indicating wrench and follow the manufacturer's recommendations for torque tension. If these are not available, it is safe to use a 12″ socket or box wrench. After pulling up a nut tight, if the cotter-pin hole is not visible, bring the nut up further—do not back it—until the cotter pin can be inserted. Never use old cotter pins. Where lock nuts are employed instead of cotter pins, tighten the bolt nuts firmly, put on the lock nuts with the open side out, turn them finger tight, and then give them a half turn with a wrench.

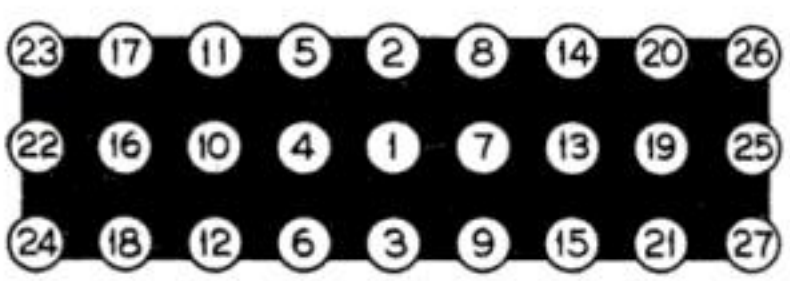
Clean the gasket, cylinder head, and cylinder block of carbon and dirt, and then place the head on the block. The bolts and nuts should be tightened in the order recommended by the manufacturer or, if his instructions are not available, according to the charts shown at the bottom of this page. Use a torque-indicating wrench or one with a 9″ handle. Cylinder-head bolts and nuts should be drawn down evenly and gradually with the operation repeated until all are normally tight. Final tightening on iron heads is done after the engine has been run long enough to bring it to operating temperature; on aluminum heads, allow the engine to become cool after running and do the final tightening while it is cool.

SEQUENCE FOR TIGHTENING CYLINDER-HEAD BOLTS



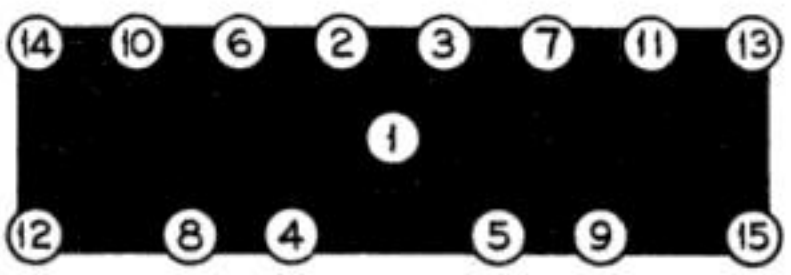
Six-cylinder L-head engine

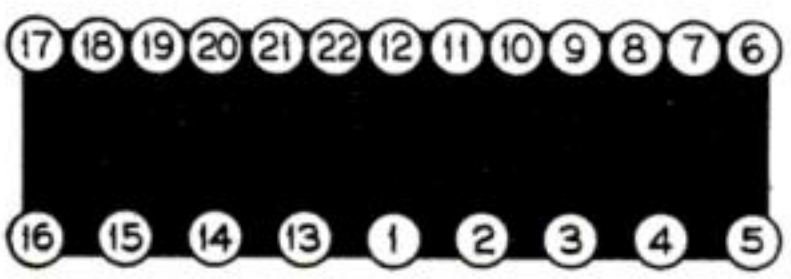
Six-cylinder overhead-valve engine



Eight-cylinder L-head engine

Eight-cylinder overhead-valve engine

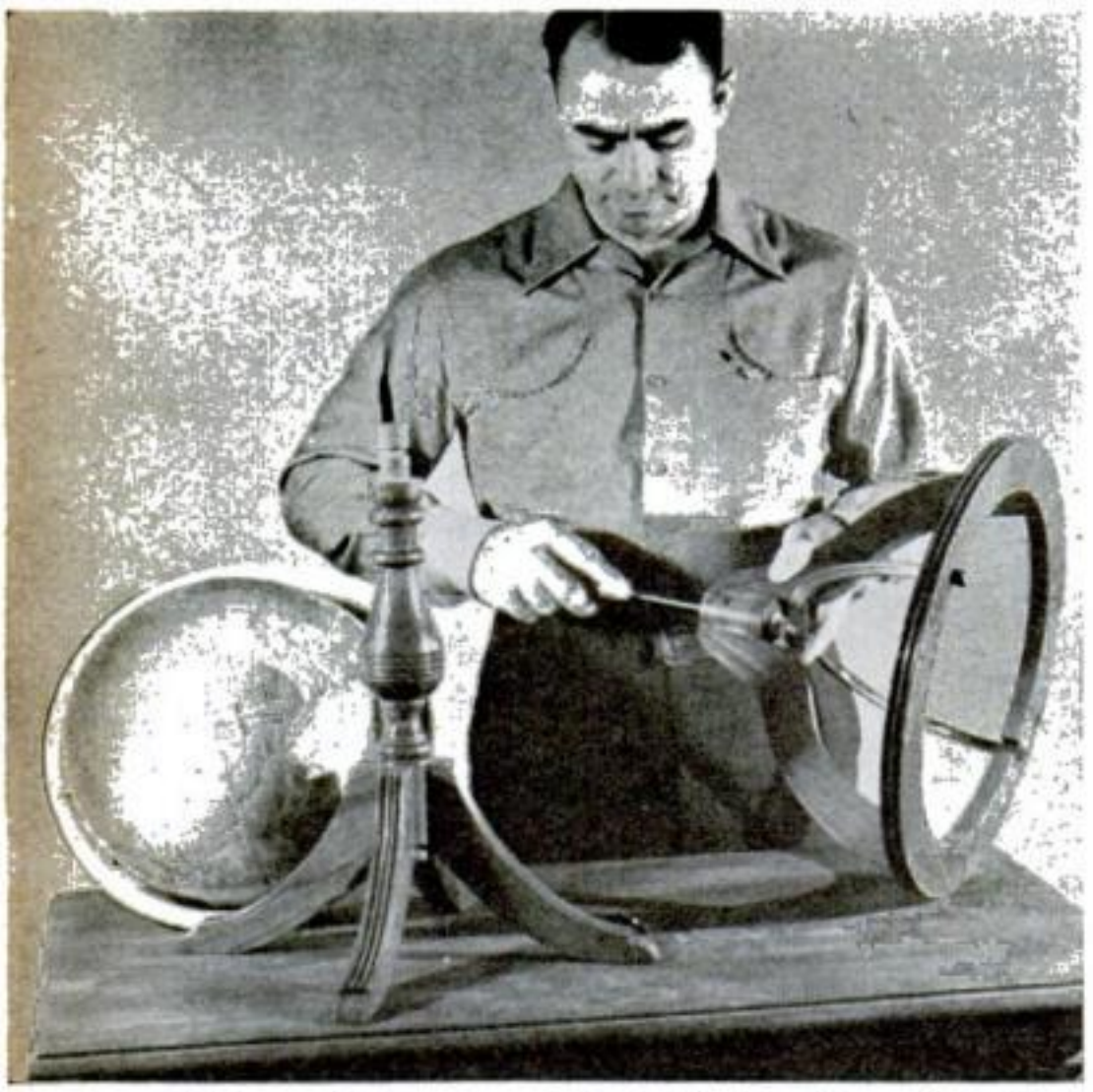




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Globe Standard

IN THE DUNCAN PHYFE STYLE

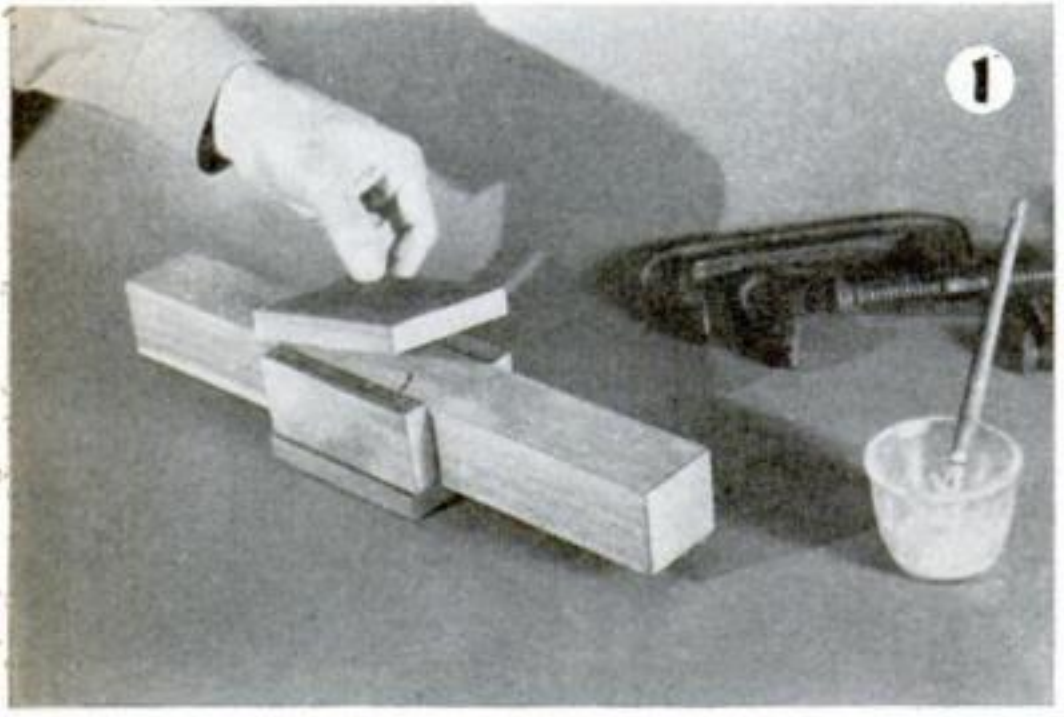


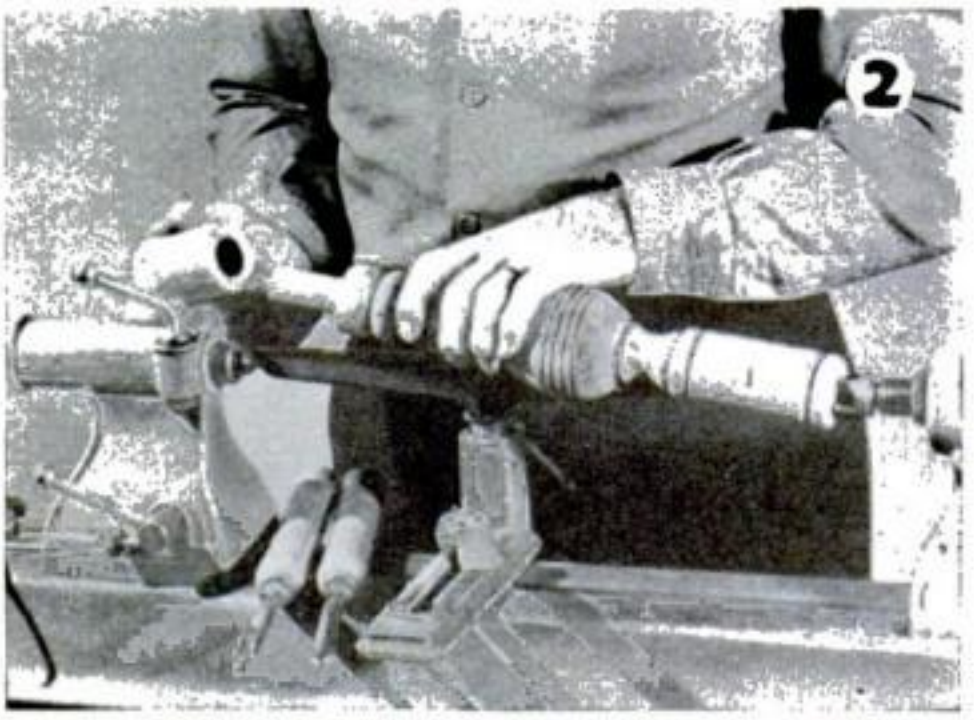
The lug of the meridian channel is bolted to the swivel block

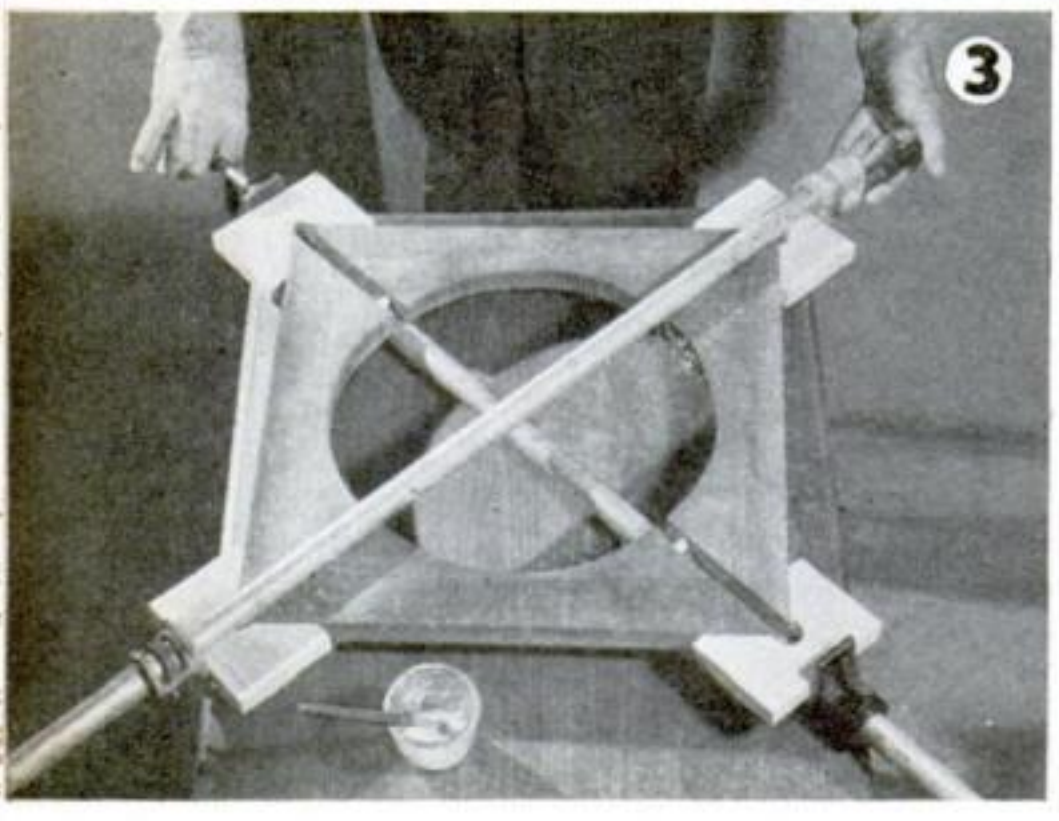
FOR those who like their world maps in the shape of a globe, this Duncan Phyfe standard will prove a handsome piece of furniture in the study or living room. Mahogany is always suitable for furniture in the Duncan Phyfe style, but any good cabinet wood can be used.

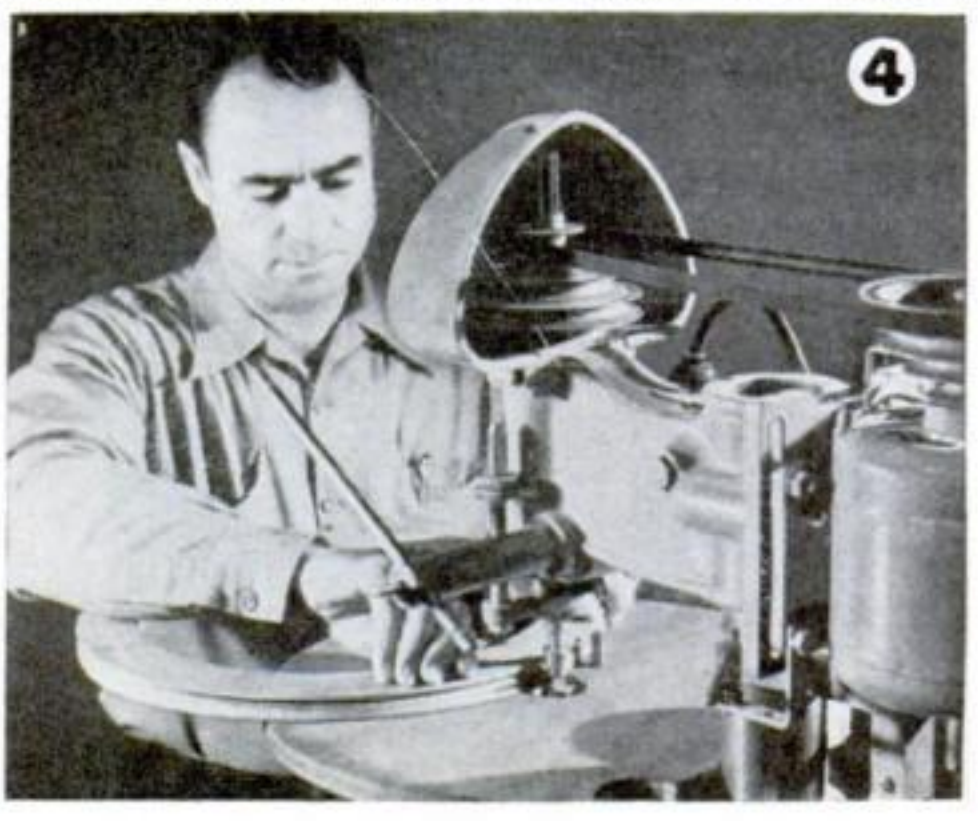
The standard shown was made for a 12″ globe, and the dimensions in the drawing can be changed to accommodate one of a different diameter, but be sure not to have the outside diameter of the horizon ring much greater than the overall spread of the feet or the steadiness of the piece may suffer. You will find the height given convenient for chairside use. The top section containing the globe rotates on a swivel block, and the globe itself revolves on its axis.

For the sake of conserving material, the thicker section of the central turning was post-blocked, as shown in one of the photographs. This method requires accurate centering in the lathe. Dowel holes for the feet may be bored after the









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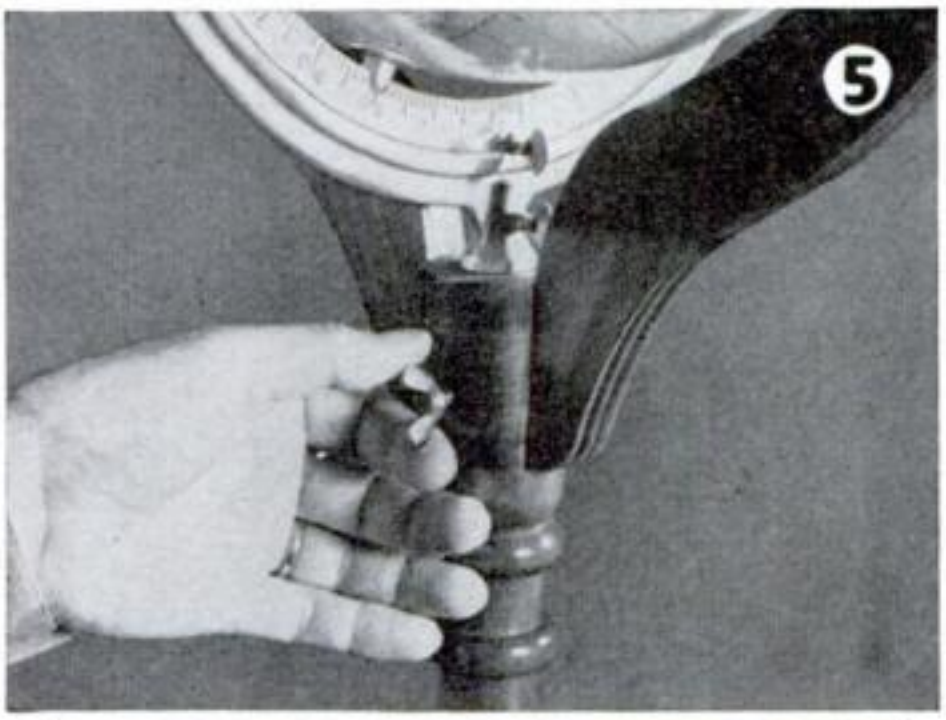
By

FRANK HEGEMEYER

turning is made. The feet have a concave face where they fit the turning, and are decorated with beading as are the arms and horizon ring.

Make up the horizon ring of four sections shaped as shown by the dotted lines in one of the drawings. Dowel them together temporarily and lay out two circles, 13" and 16½" in diameter; then take them apart again for bandsawing the inside circle. Note that two of the segments are slotted to take the metal meridian ring with which the globe is provided when purchased. Any variation of the 2½" measurement between the swivel block and globe, which may be caused by a lug mount different from that shown, can be compensated for by the length of the arm stems where they join the swivel block.

After sanding and a trial assembly, glue up the piece and allow the glue to harden. If the wood has an open grain, apply a filler slightly darker than the wood and give it 48 hours to dry; then wipe the piece and finish with lacquer, varnish, or oil.



1 Glue pieces on the turning block to take care of the extra thickness at the center

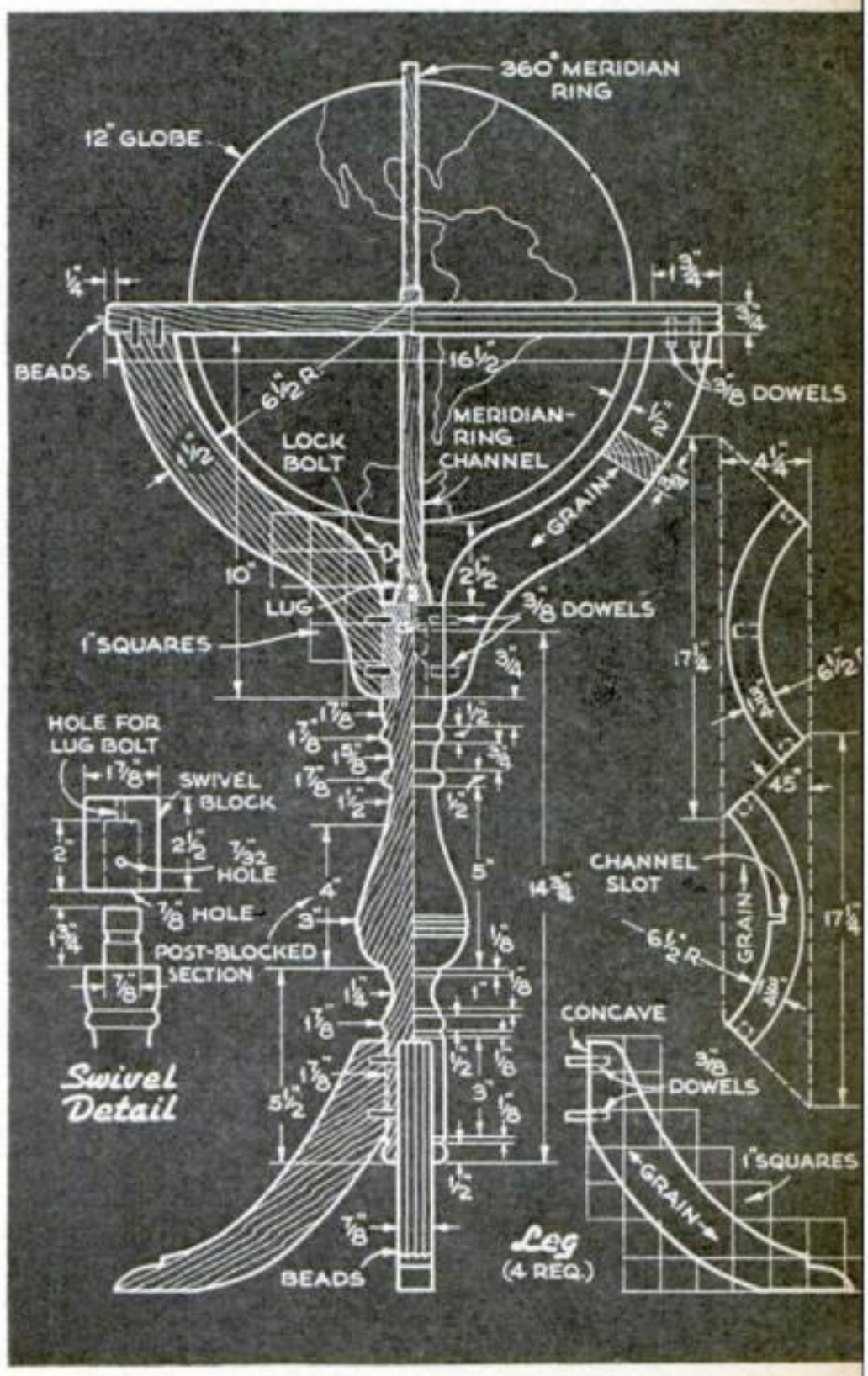
2 Dress the tenon on the upright at the lathe tailstock to fit the swivel block

3 Crisscross the clamps for solid joints in doweling and gluing the ring. Bore a 1" hole at the V's or trim the frame corners

4 A drill press may be used for beading the feet, arms, and horizon ring if no shaper is available. The highest speed is best

5 Put a threaded wing bolt into the swivel block to fit into the groove in the tenon. Bore the hole small and tap with the bolt





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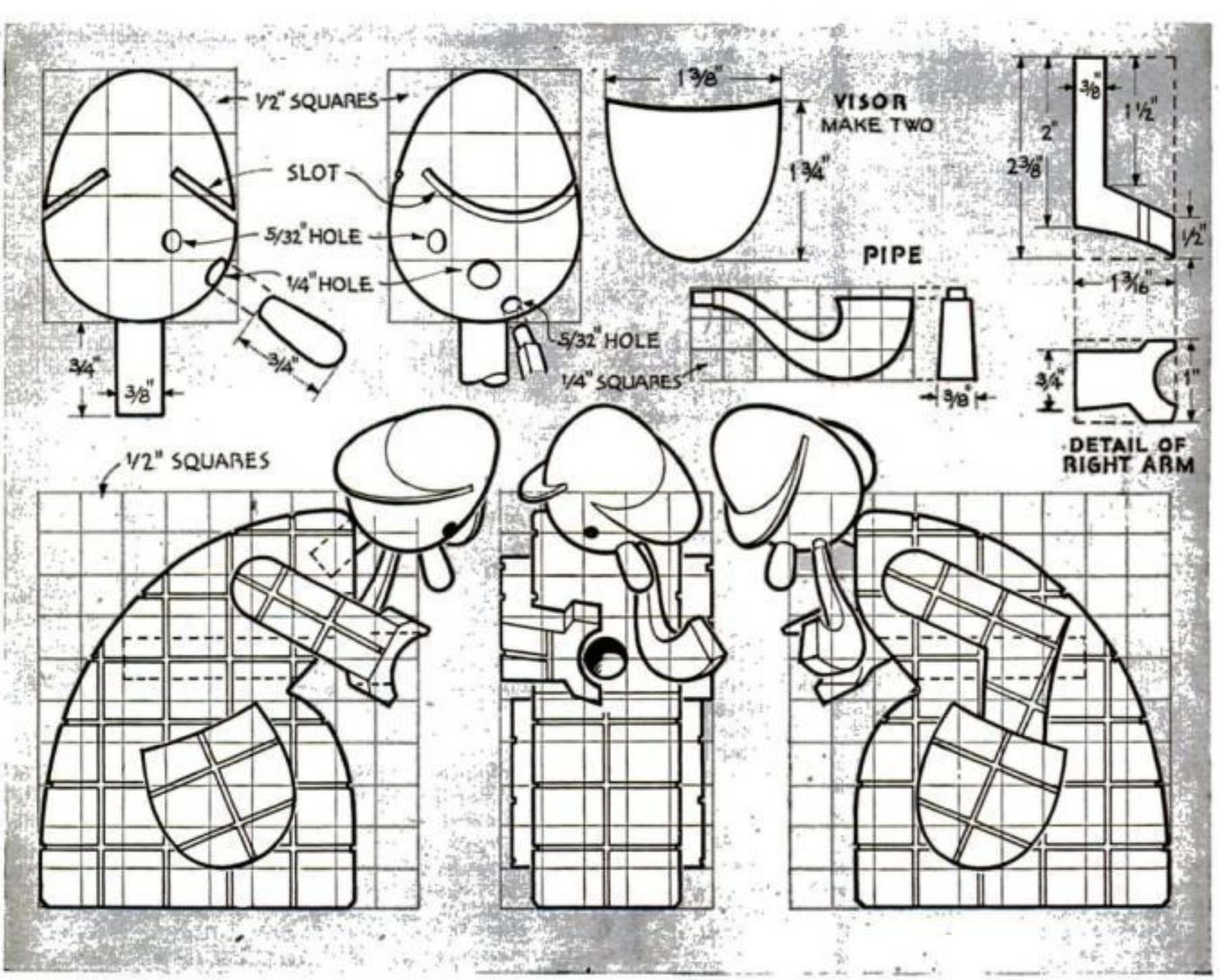
HAWKEYE

the Sleuth...

IS DISGUISED AS A READING-GLASS STAND

A DISTINCTIVE desk ornament as well as a real help in reading fine print or in examining minute details, this little hardwood figure is amusing to make. Its size may of course vary with the diameter and focal length of the reading glass at hand; the proportions shown are suitable for a glass 2½" in diameter, with a working distance of 3".

Bandsaw the profile from a glued-up block and bore a hole that takes the reading-glass handle snugly. The head and neck are turned from one piece, with two 5/32" holes drilled for the eye and pipe. A back saw will prove handy in cutting the slots for the checkered pattern and the visors. The pipe, nose, arms, and pockets are glued in place, and then the figure is lacquered.—C.W.B.

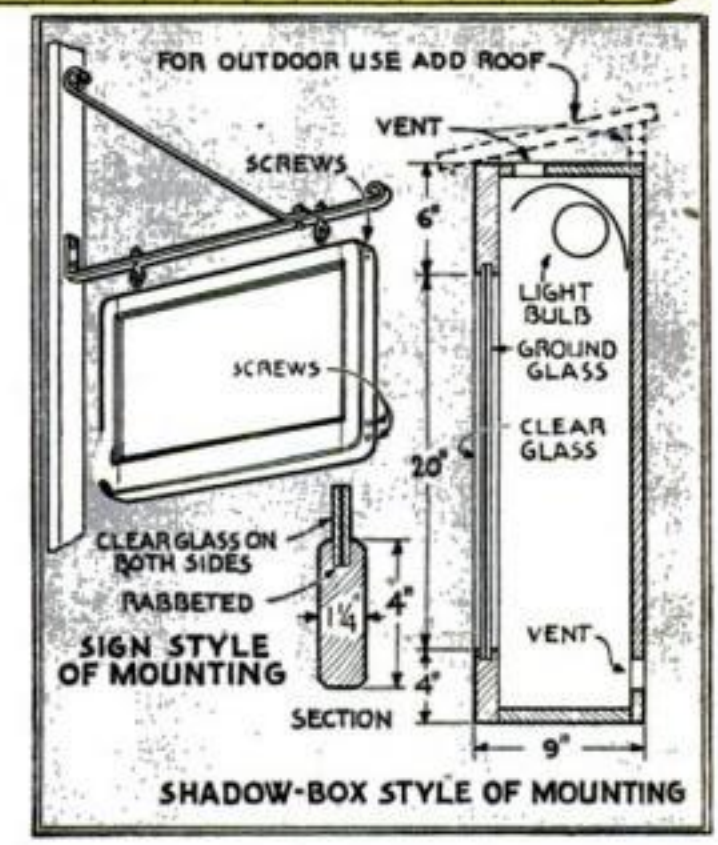


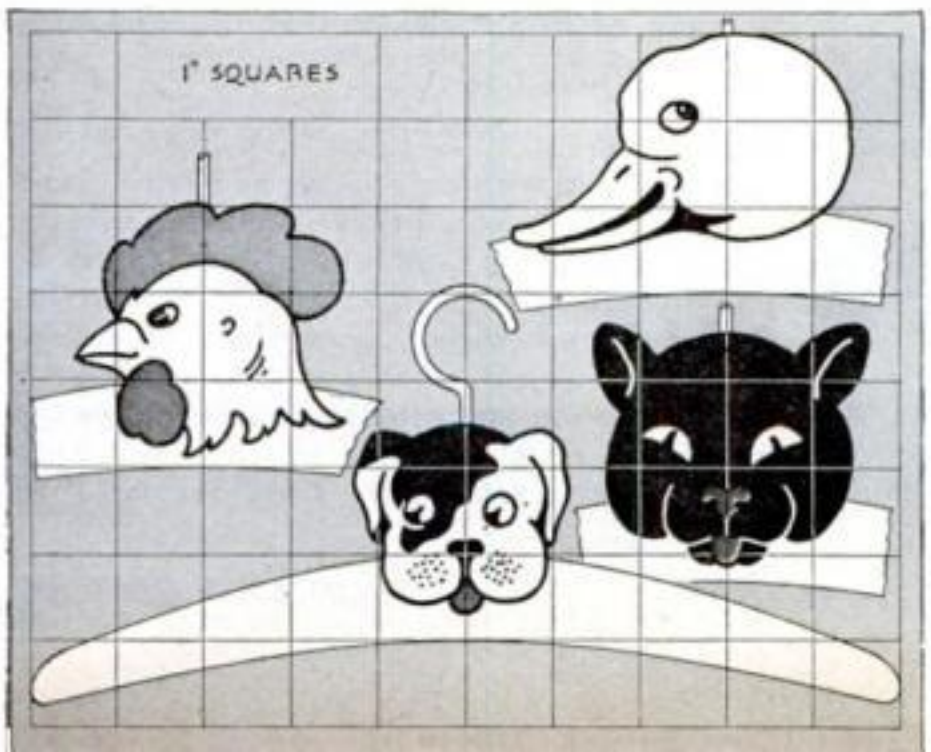
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Silhouette of Horseless-Carriage Era

FOR the imaginative craftsman, this story-telling silhouette lends itself to a variety of applications. It was originally conceived as a sign to be hung out before a country garage, bearing the legend "Complete Service for Horseless Carriages" in old-style lettering. The same design is adapted, however, for indicating the name of a householder, as a sign for many roadside enterprises, and even as a wall decoration in study or den. If desired, the silhouette may be cut from black cardboard and sandwiched between two pieces of glass, both clear in the case of a swinging sign, or the inner one frosted if a shadow-box display is adopted. Suggested exterior mountings are shown at the right. It's also possible, of course, to make an attractive jigsawed version of the pattern in either wood or sheet metal.—HI SIBLEY.



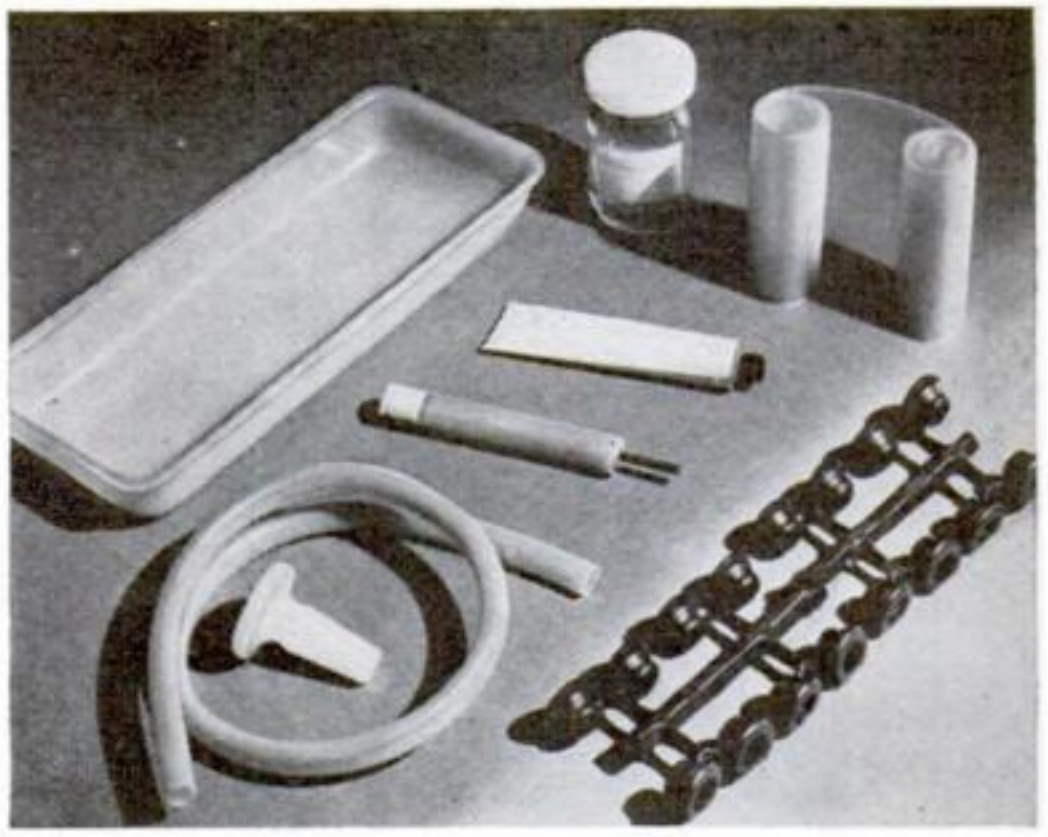


Pets on Child's Coat Hangers

COAT hangers bearing familiar bird or animal heads will aid in teaching children to hang up their clothes. Saw them from ⅜" white pine, sand smooth, and fit with large screw hooks. The white cock has a red comb and wattles, yellow bill, and black lines; the dog is black and white, with a red tongue; the duck is white, with a yellow bill and black lines, and the black cat has a pink nose and green eyes.—GRAY WOLF.

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AIDS TO *Modern Living*



FLEXIBLE PLASTIC TUBES for toothpaste and rigid jar tops are made out of the same material, a new tough plastic manufactured now in commercial quantities following five years of experimentation with polymerization of ethylene. Besides the collapsible tube and jar top, the ice-cube tray, tubing, wire insulation, stopper, sheeting, and grommets shown at the right were also made from the new plastic, which is in use now solely for war purposes. In thin sections, the plastic is nonrigid without being limp, but in thick pieces, it compares with the more rigid of similar substances. It is chemically inert, will serve in a wide range of temperatures, and is resistant to penetration by moisture



THIS WASHING SOLVENT works in cool water, and will thus eliminate shrinkage that is the result of hot-water washing. Two or three teaspoonfuls of the liquid prepare ½ gal. of water. The solution, which should just cover the articles, is said to remove dirt and grease from any washable fabric and to soak clothes clean within a matter of 10 or 15 minutes

A CHARGER for restoring flashlight batteries can now be used on an automobile without running down the car battery. This unit, attached to the steering column of a pleasure car, truck, or bus, will work even when the motor is not running. Batteries, not yet available to the public, are like storage batteries and are of a plastic impervious to the effects of battery acid. The packing around the battery plates is first saturated with distilled water applied with a medicine dropper when the filler cap is removed. These batteries are used just like dry cells





HERE IS A LINE MAGNIFIER that will be of special use for those who read and reread V-mail. Made of optically ground cane glass, it enlarges handwriting or printed matter 2½ times. This magnifying strip is a help also in reading directories, maps, and time-tables

SURFACE PROTECTION FOR MASONRY is now possible with an entirely new type of coating developed from irreversible inorganic gels, which harden on concrete, stucco, brick, and the like to form a microscopic "spongelike" film that resists the penetration of moisture from without but permits vapors within a wall to escape during temperature changes. This new product is available in five basic colors. One coat is sufficiently thick for most uses

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Bicycle Trailer and Shopping Cart Are Combined in One Unit

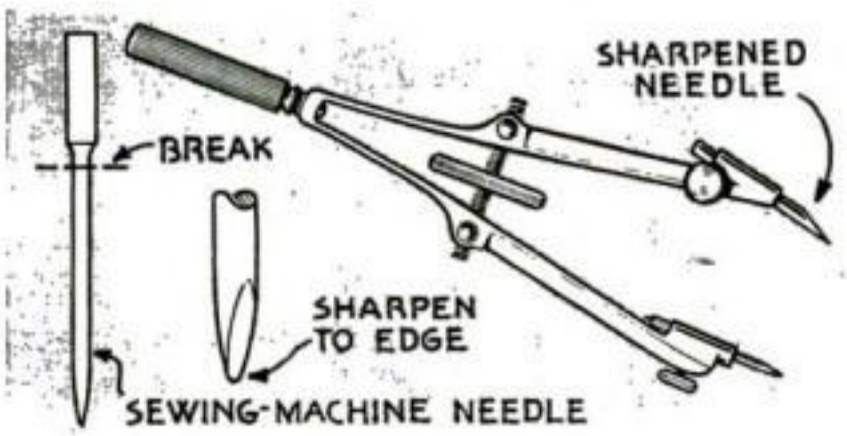




Coupling a cart behind her bike, a shopper can ride home from market when time and distance make it inconvenient to walk to the stores

USED either as a hand-pushed shopping cart or as a trailer for a bicycle, this light, home-built conveyance can be maneuvered handily with a full load of bundles. The handles, brackets, and wheels, taken from an old baby carriage, are attached to a body of ¼" plywood erected on a base frame, which is built of 1" by 2" oak and screwed to the axle. Outside dimensions of the body are 12" by 15" at the bottom, 15" by 16" at the top, and 24" in height. The bottom sections of the body are screwed to the frame, while angle irons secure the four outside corners.

When used as a trailer, the cart is coupled to the bicycle by a leather strap passed through a metal loop on the cart handle, and the two pivoted legs are moved back out of the way.—WILLARD ALLPHIN.

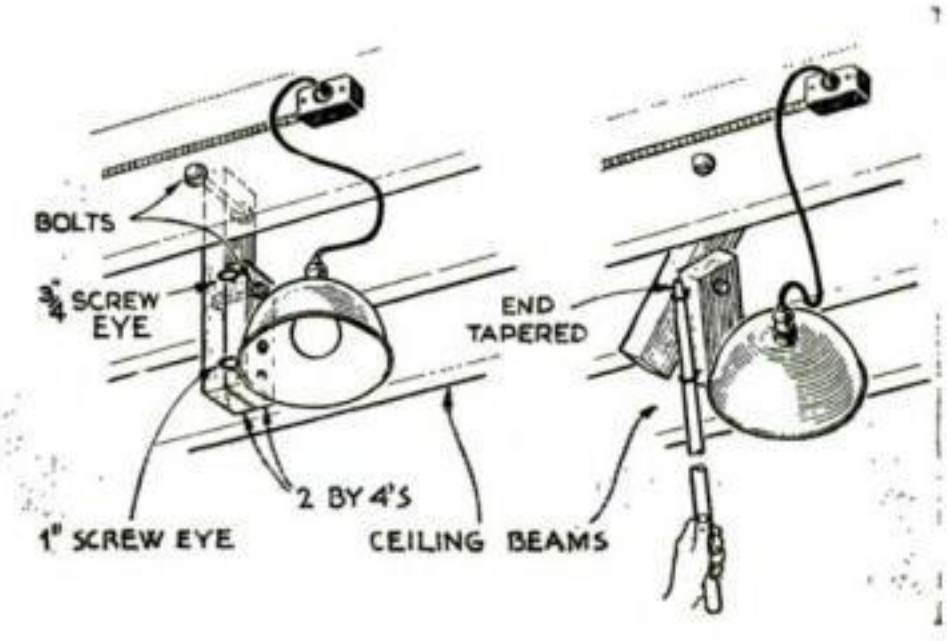


Pattern Cutting with a Compass

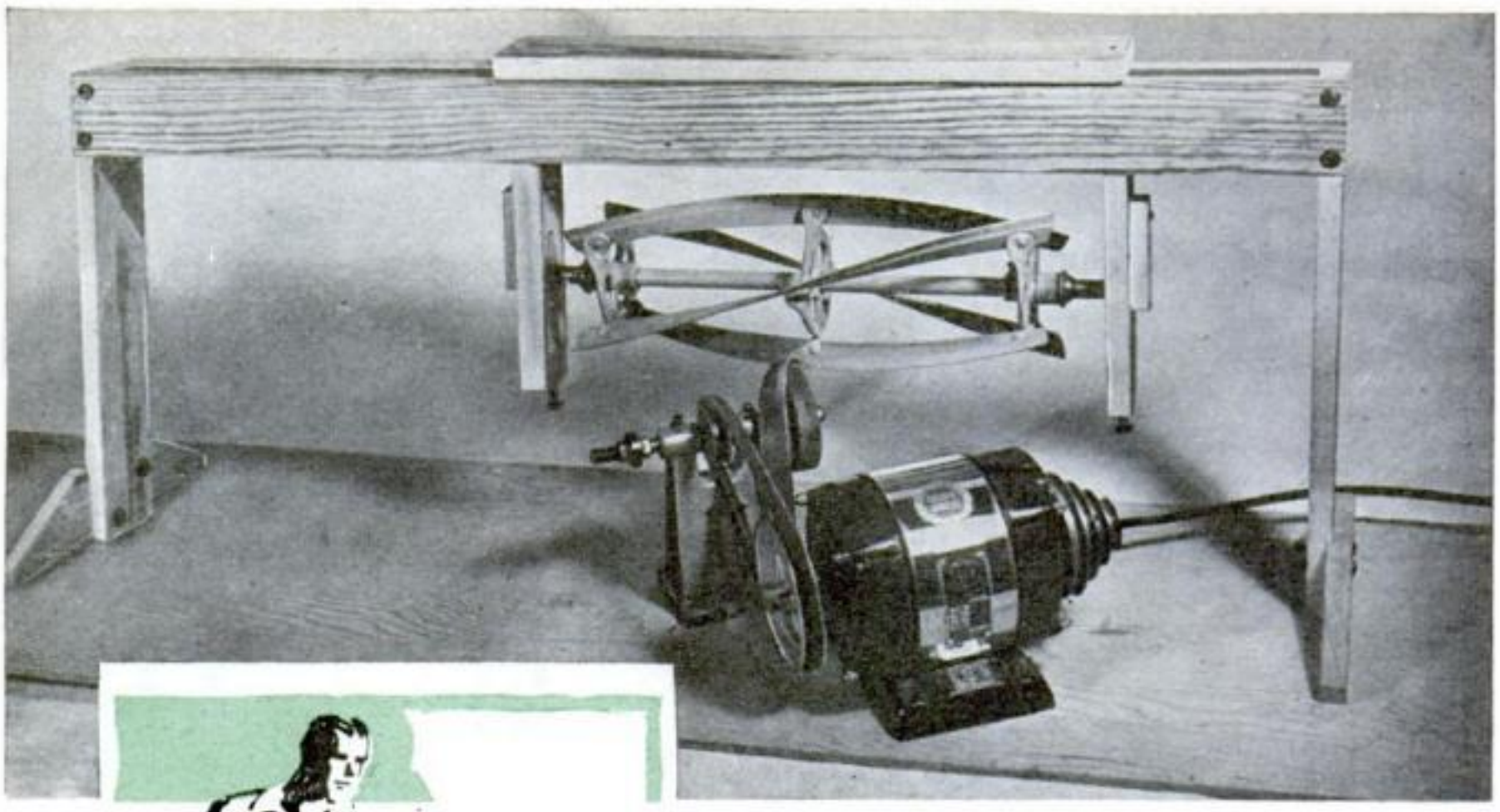
SMOOTH circular patterns can be cut in paper by fitting a standard compass with a large sewing machine needle that has been cut off ⅛" below the shank and sharpened to a flat edge. The shank is about the same size as the standard compass-pencil lead. For an engraver's tool, fit the needle in a draftsman's pencil.—NELSON P. GUIDRY.

Swivel Bracket Provides Shop with Adjustable Work Light

MADE from scraps of two by fours, some carriage bolts, and screw eyes, an electric light bracket like the one in the drawings can be attached to a ceiling beam, yet be easily adjusted from the floor by means of a pole. The nuts on the two pivot bolts should be just tight enough to hold the fixture in any position and still allow the parts to be moved. Wax the rubbing surfaces to reduce friction.—J. MODROCH.



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LAWN-MOWER SHARPENING RIG

Eases Grass-Cutting Chores

By FRANK WHEELOCK

LAWN-MOWER blades, so hard to sharpen properly by hand, are automatically ground to the correct angle on this simple rig. The apparatus consists merely of a motor-driven grinding wheel and a wooden jig, the latter being a set of overhead ways and a carriage.

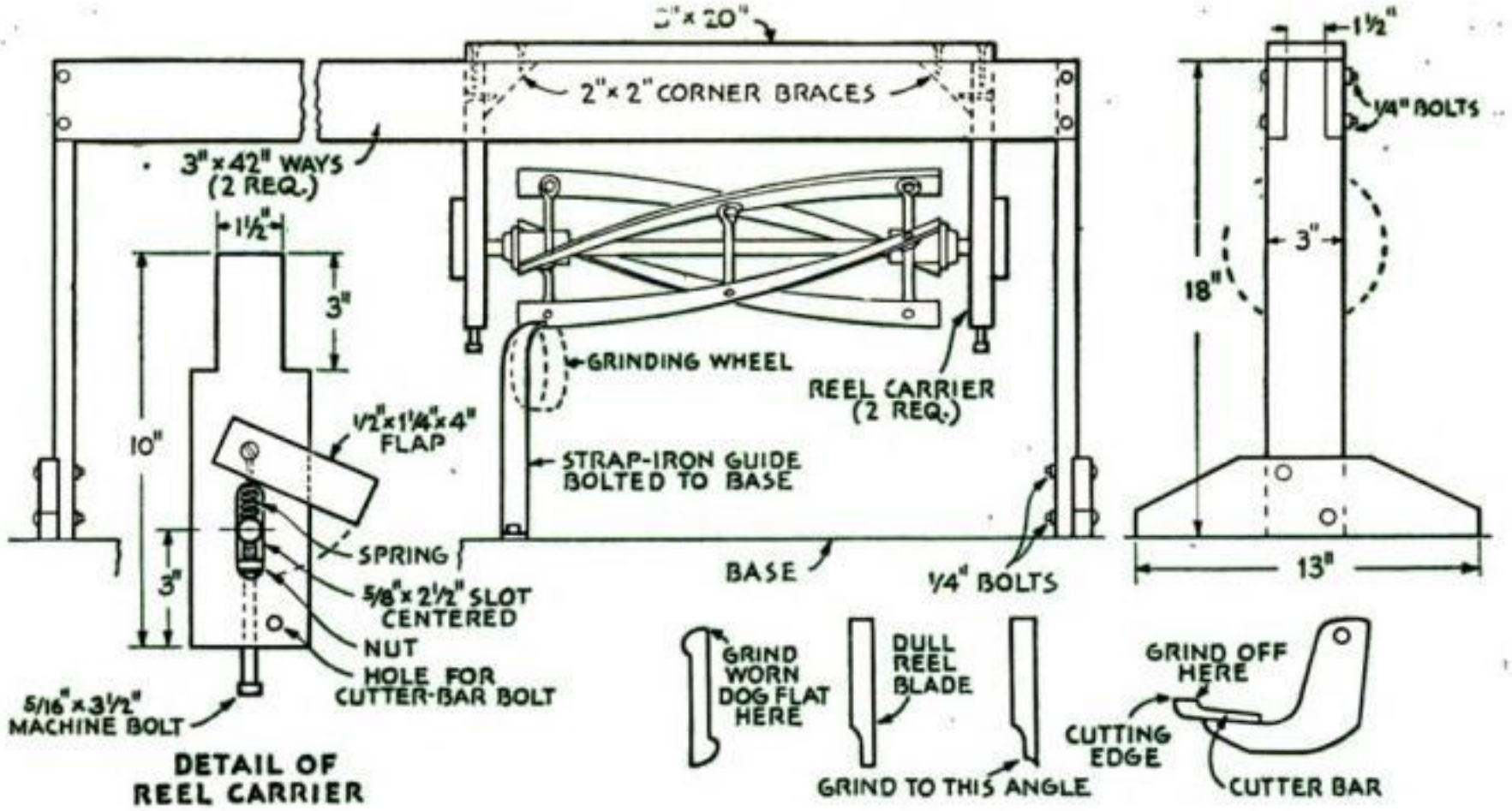
No skill whatever is needed to put a new edge on both the spiral knives and the cutter bar with this outfit, which will put even an old machine in good condition for its summer work. The part to be sharpened is inserted in the carriage and then simply pushed across the face of the rotating grinding wheel. A jig of the dimensions shown will sharpen a 16" mower. Make the carrier and ways longer if your machine is larger than this. Stock ¾" thick will serve for all parts.

Particular care must be taken to see that the ways are perfectly straight. Use well-seasoned hardwood if possible. The legs, 18" high in the drawing, were built for use with a grinding wheel 8" high at the top. Any grinding head, flexible shaft, or similar accessory on which a grinding wheel can be mounted will serve if it is rigidly fastened to a flat surface, the standards being built to suit the height of the wheel. The ways are simply arranged over the wheel, as shown in the photo above, or their legs may be fastened permanently to the base. Note that the ways are at an angle to the face of the grinding wheel, thus permitting a curved blade of the mower to come into contact with the wheel evenly at all points.

Insert the blade reel in the carrier and adjust the bolts to bring both ends of the shaft to exactly the same height and one blade into contact with the grinding wheel. Bend the guide arm so that the blade will be ground at an angle, as shown in the drawings. With the wheel running, push the carrier slowly along the ways. The friction of the grinding wheel will hold the blade against the guide. Grind all the knives without altering the height of the reel. Then, if further grinding is necessary to obtain a good edge, turn both adjusting screws equally to lower the reel and make another pass along all the blades.

To sharpen the cutter bar, fasten it in the carrier with the same bolts that secure it to the mower. Remove the strap-iron guide used in sharpening the reel, tilt the

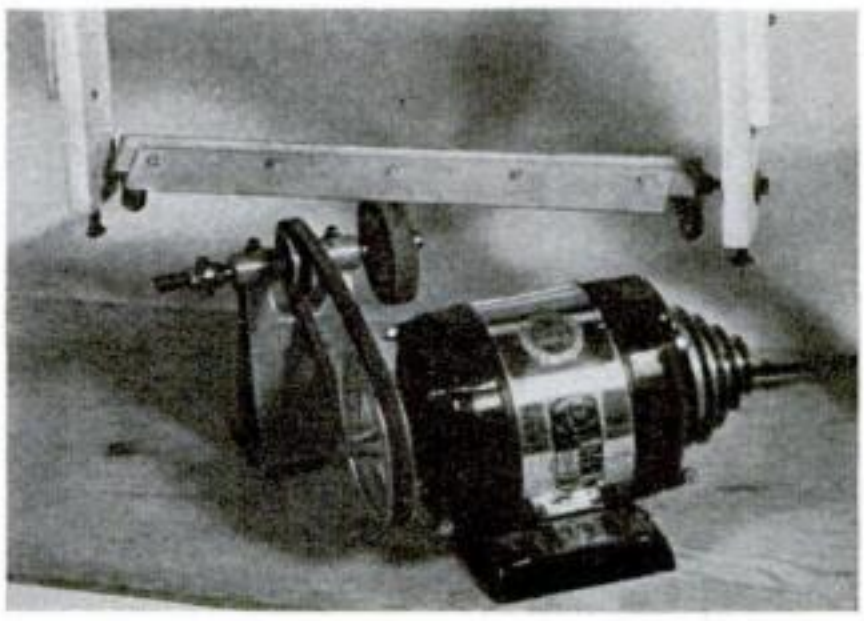
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cutter bar against the grinding wheel, and slide the carrier along, grinding off the rear of the flat to form a cutting edge at the front, as at right and in the drawing.

Worn ratchet dogs can often be salvaged by grinding flat those portions burred over by wear. This, of course, is not an automatic job to be done with the sharpening jig; a dog is held to the wheel by hand.

Clean grease and dirt from the cogs before reassembling the machine. Adjust the bearings so that the reel spins freely but without play. Then adjust the cutter bar against the blades so that they just clear it with a characteristic whispering sound. Painting the roller prolongs its life.



Grinding an edge on a lawn-mower cutter bar after sharpening the blades perfects the cutting action

MAY CHECK LIST

[*SHIPSHAPE HOME*]

1. Clean out garage and repair concrete floor and apron.
2. Repair porch or stoop steps and patch walks and driveways.
3. Overhaul, clean, and paint awnings and fastenings.
4. Inspect flat canvas and metal roofs for signs of deterioration.
5. Open attic windows or louvers and basement windows for summer ventilation.
6. Cover cold-air returns and open basement and attic doors.
7. Clean the heating system, draining and refilling the boiler if it is dirty.
8. Do outside painting in early dry weather before the arrival of summer insects.
9. Jack up sagging joists and replace rotted beams or sills.
10. Take up all rugs and carpets and fill floor cracks.

POPULAR SCIENCE MONTHLY SHOP DATA

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Special Jobs for Your Jigsaw

By EDWIN M. LOVE

HARDLY a machine in the home workshop will be found more versatile than the power jigsaw. Besides filling all the ordinary requirements, it can be used to cut tenons, dadoes for half-lap joints, and dovetails, and to turn out a variety of scroll and pattern sawing. Special ornamental work, such as cutting beads on square table legs and fluting short turnings, is readily accomplished with this valuable tool.

How are tenons cut with a jigsaw? Gauge guide lines for the thickness on one edge of the piece and width lines on one face, and then square shoulder lines all the way around. Use the widest saber blade, rip the cheeks first, the edges next, and finish by cutting the face and edge shoulders.

On a workpiece that is not square all the way around, the cheeks can be made parallel with the face by standing the stock on edge by the *side* of the blade and tilting the table sufficiently to true the side of the blade with the entire width of the face. Return the table to a 90-deg. angle with the blade for ripping the edges.

If several identical tenons are to be made, it is wise to use fences and stops. Cut the pieces to allow for exact tenon lengths, and set up a fence by clamping a strip of wood to the saw table. Not only must the distance of the fence from the blade be correct, but the fence must also be parallel to the line of cut, which in some cases may depart from the center line of the table because of the blade leading to one side. A pivot fence set up as shown in one of the drawings allows freehand guiding while fixing the location of the cut and may be used if preferred. Clamp the ripping-depth stop where the end of the piece will butt against it when



Spiral flutes are cut on a short turning with a file chucked in place of a saw blade. The large stop limits depth, while that at the operator's left gauges the start of the cut, which is made, top to bottom, by swinging the piece on the file

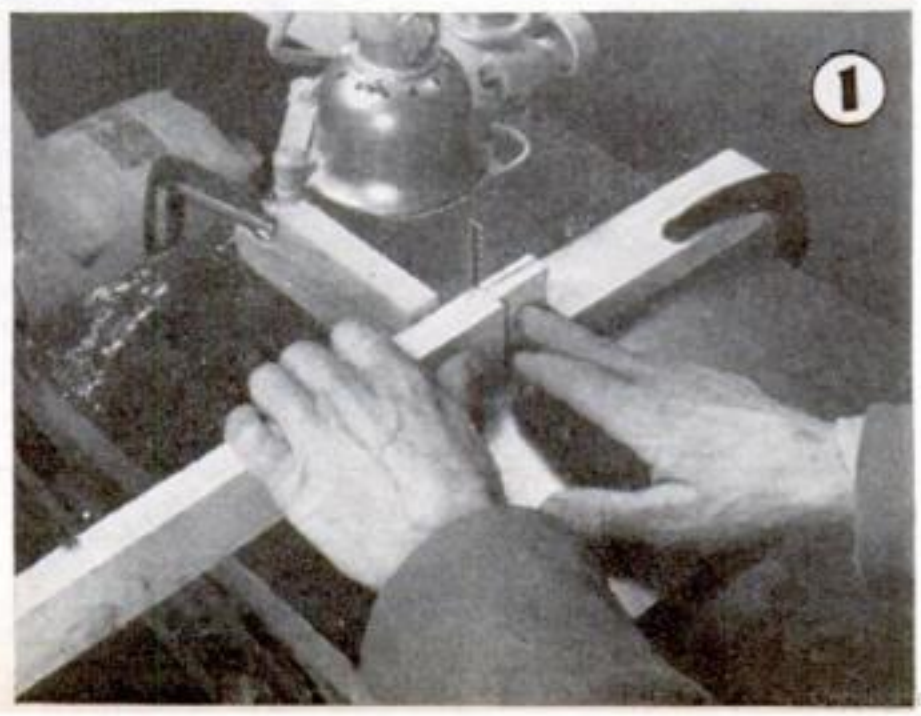
1 Cutting a tenon. The gauge block at right limits the length of the tenon, that at rear shoulder depth. The blade guide is raised for clarity

2 Curve the blade in to start the bottom of a cross-lap dado, and turn the piece to finish that corner

3 Sawing a concave edge on a short piece slid along a curved fence

4 Square table legs are scored by the saw preliminary to beading

5 Then V-cuts round the bead ends, and a file is used to smooth them



HOW TO CUT TENONS, DOVETAILS, BEADS, WOODEN SCREWS, FLUTES, AND SEGMENTS ON THIS VERSATILE POWER TOOL

the blade has sawed exactly to the base of the tenon. This is always safer than attempting to stop the cut with the aid of the guide lines alone.

When cutting the shoulder, clamp a length gauge at the right of the table and a depth stop behind the blade to limit the shoulder cut, as in one of the photos. The latter stop should be of sufficient height to keep the work from rocking forward at the top. It eliminates any accidental cutting away from the vertical into the tenon thickness. The end of the work slides along a gauge block that locates the position of the shoulder.

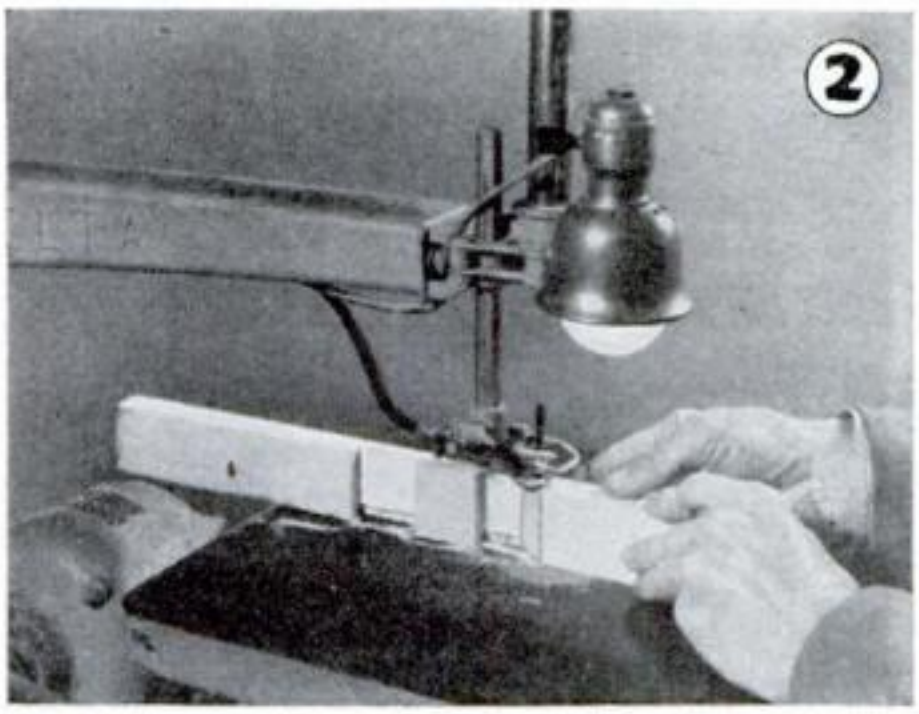
Since the fences and stops accurately locate the cuts, no guide lines are necessary. To save time, it is good practice to rip all tenon cheeks with one setup, rip the tenon edges next, and finally set up the stops to cut the shoulders.

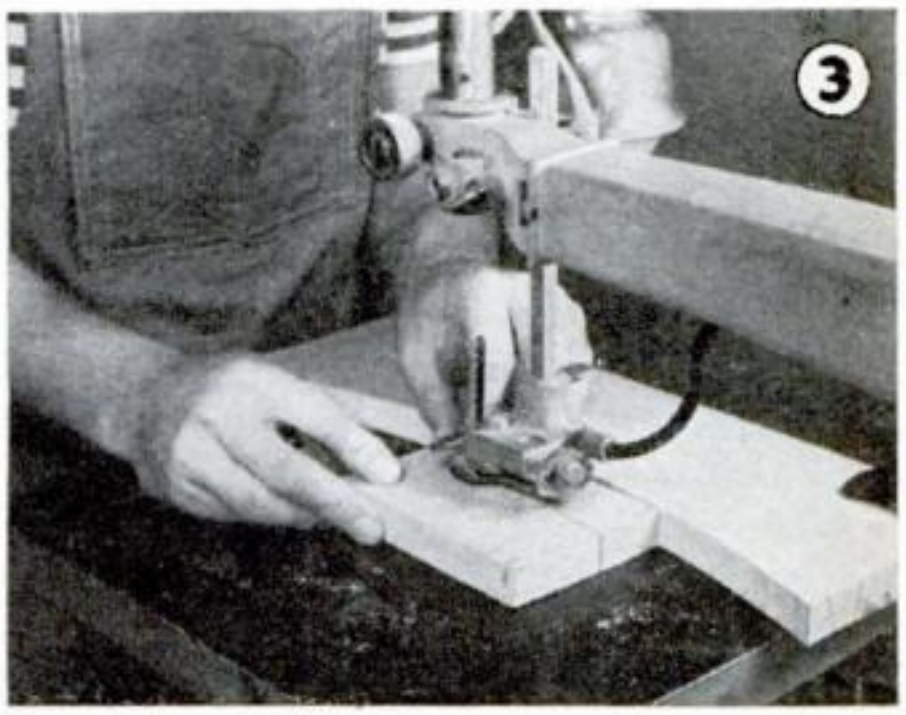
In making dadoes and half-lap joints, saw the ends like tenon shoulders, but you will have to curve in from one end to start ripping the bottoms, as shown in a drawing and one of the photos. The piece can then be turned around to cut away the curved waste and make the first corner square.

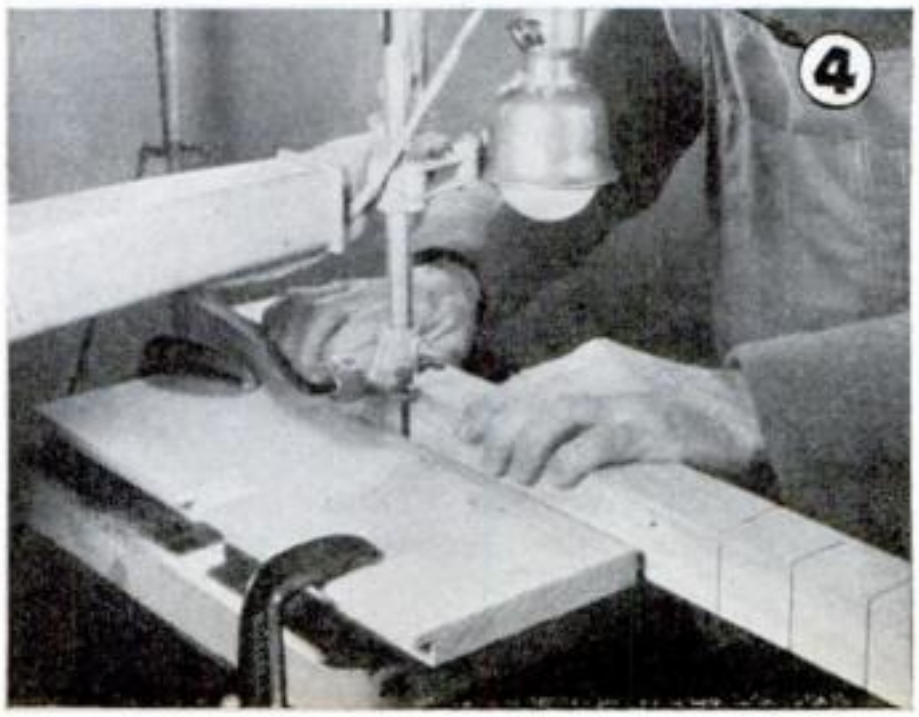
In what way are dovetails cut? Having laid out the pieces to be joined with the required number of dovetails and matching pins (see P.S.M., Apr. '44, p. 151), clamp a stop block on the saw table, rip the sides of the dovetails first, and then cut out the socket bottoms. Rip the pins with the table tilted to correspond to the slope of the dovetail sides, and cut the socket bottoms as before, leaving only narrow triangular strips at the edges to be trimmed by hand with a chisel.

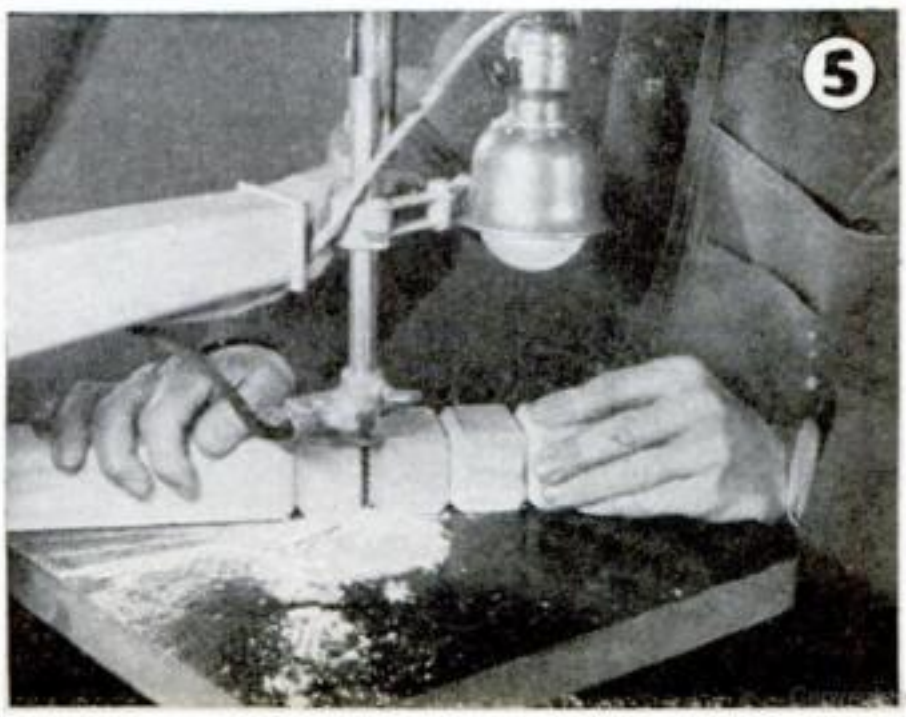
When is pattern sawing advantageous? This is principally a means of rapid duplication of pieces. Many of the methods used for pattern sawing with a bandsaw are adaptable for use with a jigsaw, but usually the thickness of the material or pad of pieces to be cut must be limited to 2″, or that amount minus the thickness of the jig base.

An adjustable jig for cutting segments of various radiuses is shown in one of the drawings. The table sections are screwed to the cleats, forming the ways for the sliding arm, which in turn is locked with a screw from beneath. [*Turn the page.*]







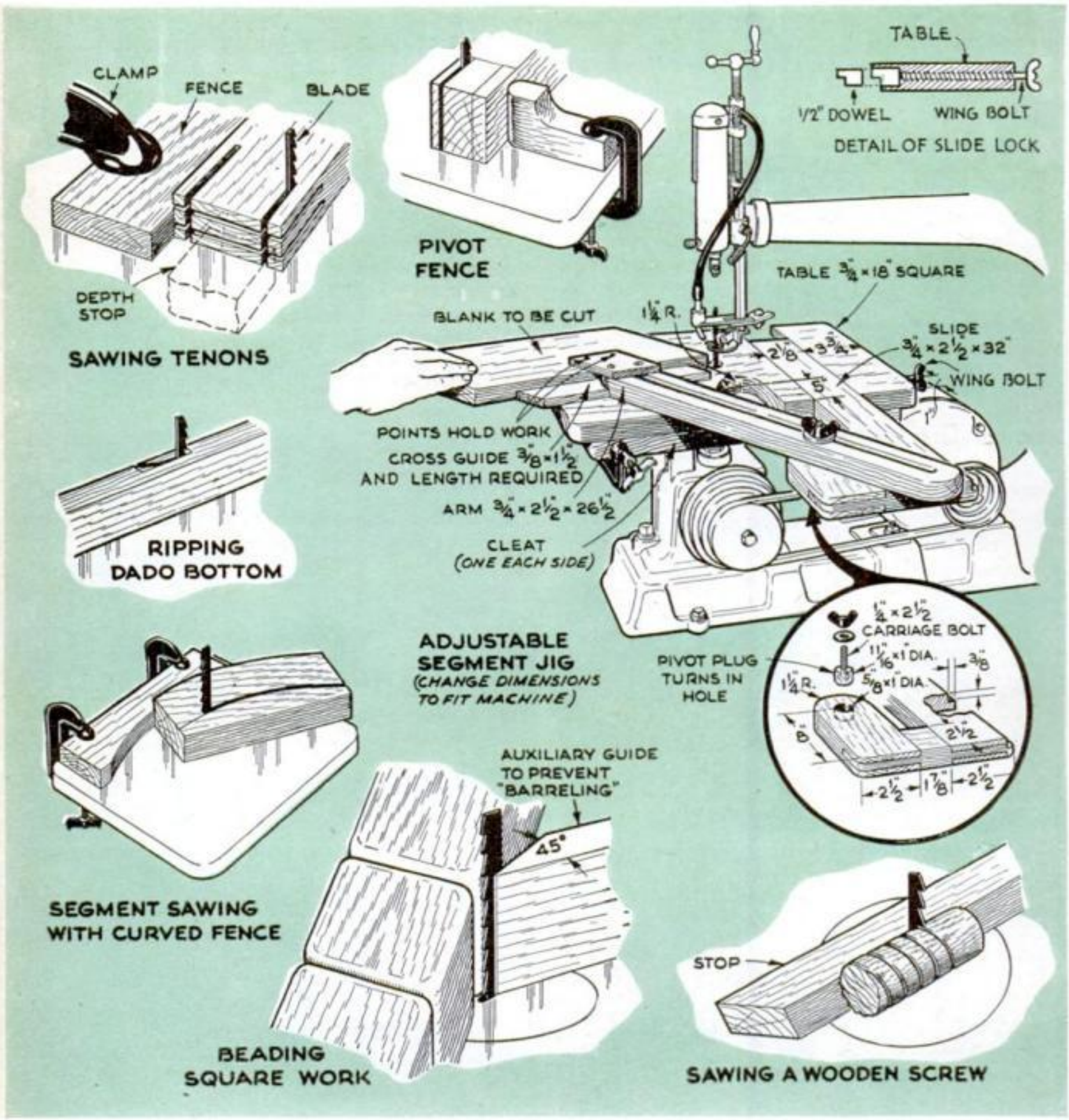


Use of the offset pivot mount allows the slide to extend through the table behind the saw blade so that the pivot can be set near the blade for sawing pieces to a short radius. Adjust the table forward or backward to correct for the lead of the blade. This jig is equally useful for smoothing the edges with a sanding attachment or a file.

One of the photographs shows a setup for cutting concave edges on straight strips. A curved fence is clamped to the saw table, and the work is pressed against it as it is fed into the blade. The same method also serves for cutting concave inner edges of segments already curved on the outer edges. For the latter operation, the fence may be shorter than the piece to be worked.

How are square table legs beaded? Set the saw table level and score between the beads with a stiff saber blade, using a depth stop, as shown in a photo. Next cut the divisions roughly V-shaped and finish by trimming them round. If the leg is thick and the blade tends to "barrel" by bulging outward in the cut, stiffen the blade by clamping an auxiliary guide against its outer edge, as in one of the drawings.

What is required for fluting turnings? Break off a suitable length of a half-round bastard file and grind the shank cylindrical to fit the chuck. Install it with one edge forward in the position of the teeth of a saw blade. Notch a piece of lumber to clamp behind the blade for a depth stop, and clamp in front of it, to the left of the operator, a guide for feeding the work against the saw.



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Mark the flute spacing with a pencil on the upper end of the turning and press the work against the file at these points to make V-grooves. If half-round flutes are wanted, go over the work a second time, using a rattail file.

In making spiral flutes, that is, at an angle from the axis of the turning, as shown in one of the photos and as required in the powder-box project that follows this article, tilt the table to the desired angle. Then, when pressing the work against the file, swing it around carefully to one side to draw the top of the turning into the file or in the opposite direction to draw in the bottom.

In making spiral flutes on a short turning such as the powder box, the situation is this: If the table were swung to the vertical, with the axis of the cylinder horizontal, the edge of the file would touch only at the perimeter of the circle. With the table level and the axis vertical, the file edge (if straight) would parallel the axis, touching from top to bottom. However, since the table is tilted to conform to the spiral design for the flutes, the file will touch only at the center of the turning if the side stop is accurately adjusted, centering on the file.

Therefore, to make a flute from top to bottom, set the side guide far enough to one side to start the cut at the top or bottom, depending on whether it is a right or left-hand spiral, and then swing the turning away from the stop to complete the flute. This, of course, must be done carefully if the flutes are to be straight lines and all are to follow the same angle from the vertical. It will not be found difficult after practice, and it will be wise to try to perfect the swinging motion first on waste stock turned to the approximate dimensions of the finished piece.

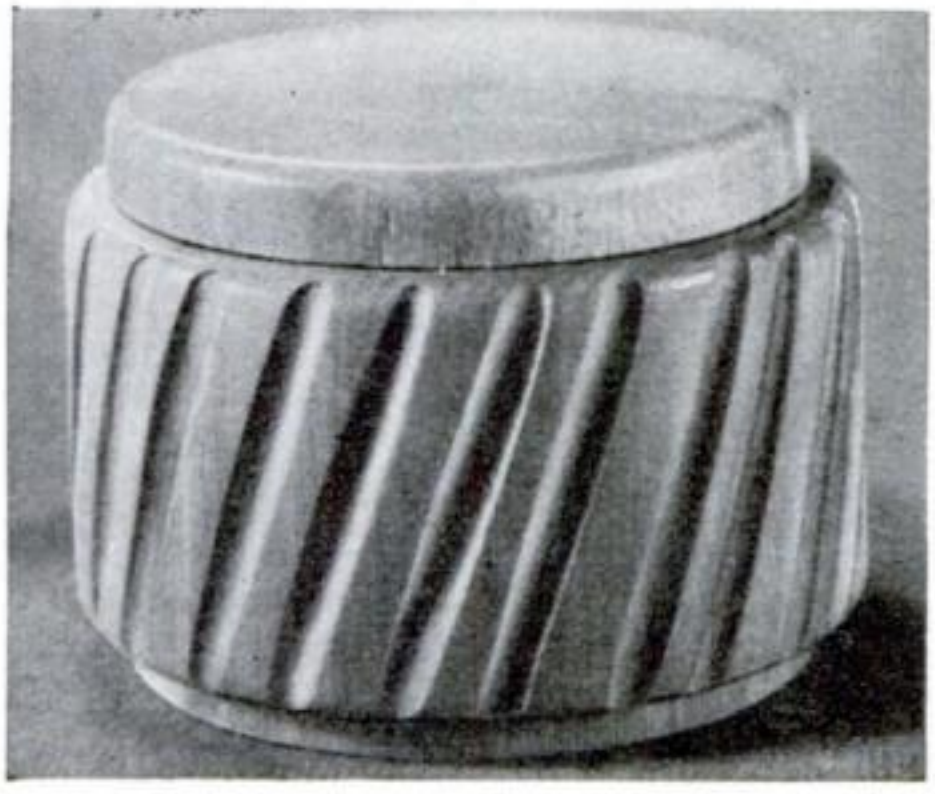
Use a variation of this method to make a wooden screw, such as the screw required in a spinning-wheel project. Tilt the table to correspond to the lead of the screw, insert a saber blade, and set the backstop for cutting slightly less than the thread depth. Starting at the left end, feed the cylindrical stock into the blade until depth is reached, then carefully screw it along as the cut is made. This done, replace the blade with a three-cornered file, adjust the stop for full depth of thread, and complete the job. Leave a flat surface 1/16" wide on top of the thread.

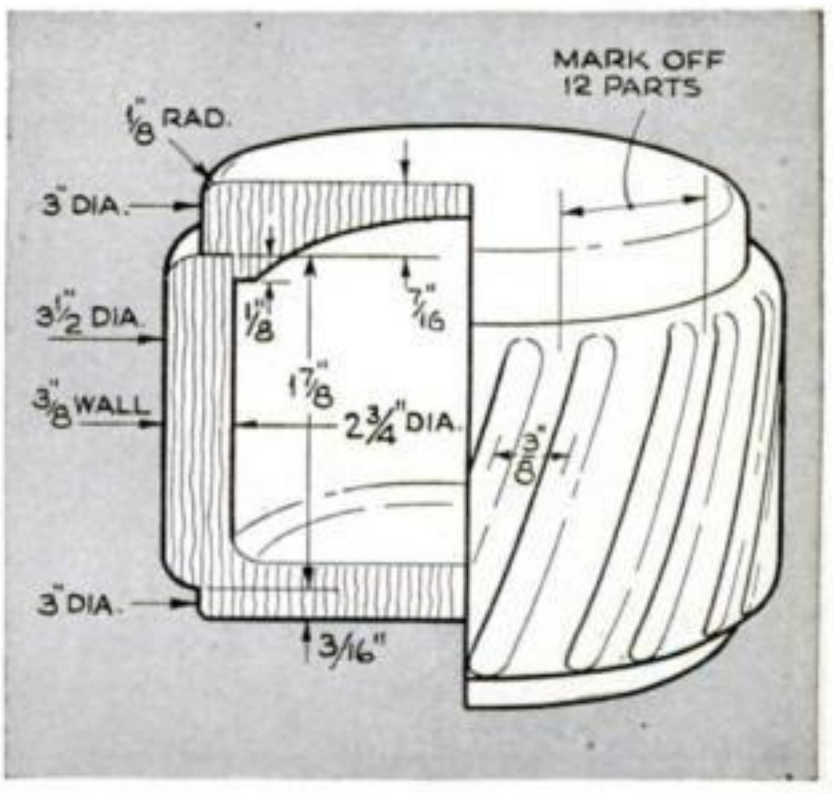
Turned Powder Box Decorated with Jigsawed Spiral Flutings

MOUNT a 4" by 4" by 6" hardwood block on a lathe faceplate and turn it to 3⅝" diameter. Face the end and turn the inside of the lid with its flange; then cut it off 11/16" from the end, which leaves ⅛" of stock for finish turning. Face the rest of the block and hollow the inside to a tight fit for the flange diameter of the lid.

Press the lid into place, then turn the top of it and complete the outside turning of the box. While the piece is still chucked, use the indexing head of the lathe to mark off 12 divisions for fluting, marking the spacing with a pencil on the upper shoulder.

Pry off the lid and sand the inside of the box enough to make the lid fit freely. Then cut off the box and shape two flutes at each division as described in the preceding article, spacing each two of a pair so that they will be ⅜" apart.—E. M. L.





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By JOSEPH ARONSON

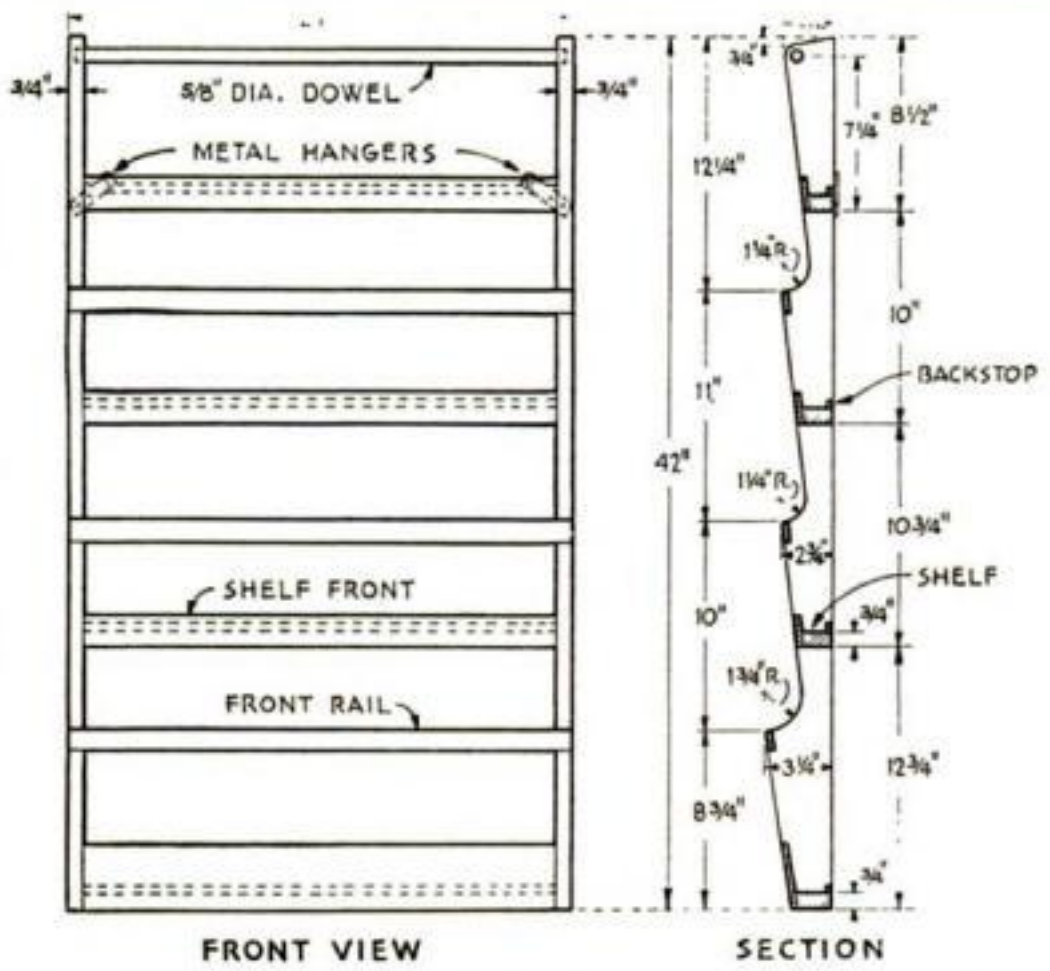
HOW to keep current magazines where they can be selected quickly for reading is a common household problem. This wall or door rack, of elementary construction, is a simple solution. It can be hung on the inside of a cupboard or closet door, if you prefer not to have it show, or on the wall in a passageway or stair landing, where those who pass may choose their reading.

Lay out the sidepiece profile, as shown in the drawing, on one piece of stock, nail another piece to it, and saw out both sections at one time. Next, lay out the shelves and shelf fronts, altering them, if necessary, to conform to the sidepieces; then glue shelves and fronts together in pairs and brad on a ¼" by ⅜" stop at the back. These troughs are then nailed or doweled to the sides. Rails are nailed on last, going on over the face of the sides to stiffen the framework. The length of all horizontal pieces should be changed in proportion if the width you decide upon is to differ from that shown here.



CLOSET-DOOR RACK

KEEPS MAGAZINES OUT OF SIGHT



LIST OF MATERIALS

NO. PC.	DESCRIPTION	T.	W.	L.
2	SIDEPIECES	3/4	3¼	42
1	TOP SHELF	3/4	1⅜	22½
2	MIDDLE SHELVES	3/4	1⅝	22½
1	BOTTOM SHELF	3/4	1¾	22½
3	SHELF FRONTS	¼	1½	22½
1	BOTTOM SHELF FRONT	¼	3¼	22½
4	BACKSTOPS	¼	⅜	22½
3	FRONT RAILS	¼	1	24
1	FRONT RAIL (DOWEL)	5/8 DIA.		23¼

2 FLAT METAL HANGERS AND SCREWS

NOTE: ALL DIMENSIONS ARE GIVEN IN INCHES

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Silk-Screen Stenciling . . .

A PROFITABLE HOBBY

HOW POSTERS, GREETING CARDS, DECORATED MATS, AND ART WORK CAN BE REPRODUCED IN QUANTITY WITH SIMPLE HOMEMADE EQUIPMENT

By J. I. Biegeleisen

YOU can hardly go through an ordinary day without coming across many articles printed by silk screen. Tablecloths, glasses, trays, book jackets, posters—these are but a few examples of the variety of decorative materials made possible with the silk-screen process.

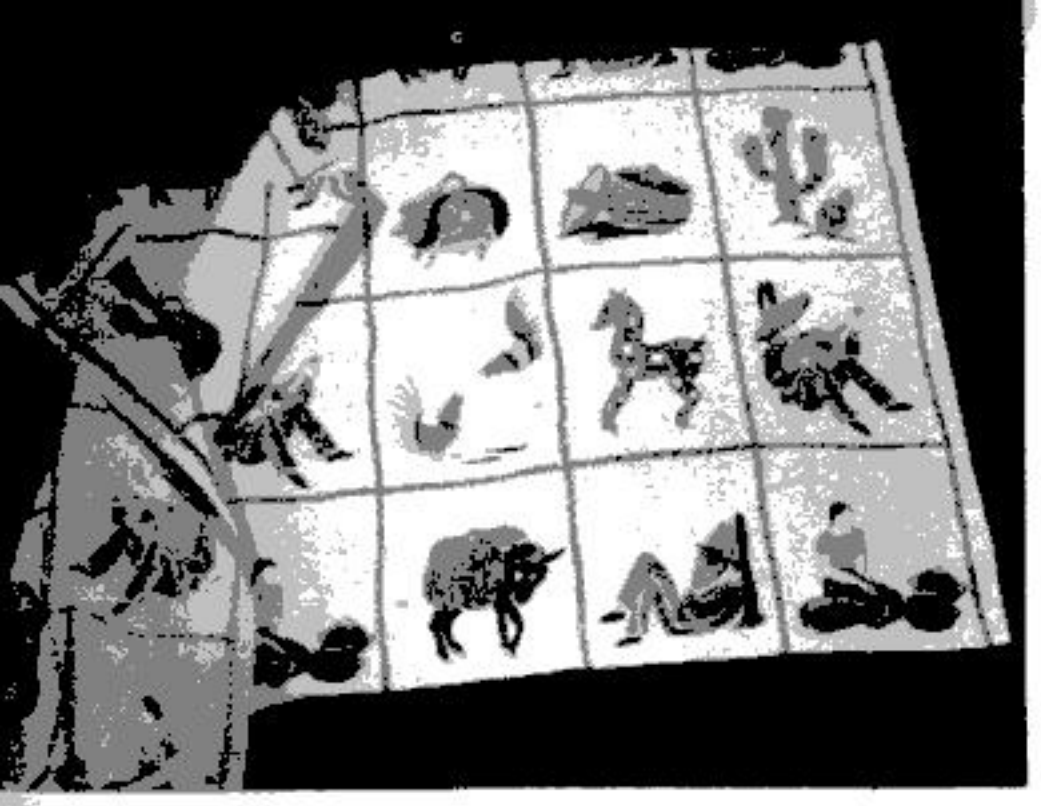
At little expense and in your own home, you can individualize your stationery, make personal greeting cards, decorate shelving, drapes, table linen, and handkerchiefs for yourself and your friends, and print game boards, emblems, colorful pennants, and magazine covers for your civilian defense organization, for your club, or for your school. You may begin silk-screen printing as a hobby and wind up with a profitable, interesting commercial venture. But no matter how or why you engage in this form of art, you will find it a lot of fun.

Silk screening is a simple printing process that works on the principle of the stencil. The design to be printed is attached to a porous screen of silk or organdy stretched across a wooden frame. When the article that is to be decorated is placed on the printing base, the screen lowered over it, and the paint pushed across the screen with a squeegee, paint will then go through the mesh of the organdy



Patriotic posters like this one can be made in quantity with a silk screen. A separate stencil is required for each color used

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wherever the fabric is "open" and leave an imprint. It will not go through where the stencil "closes" or blocks out the organdy. For a design in more than one color, a separate stencil is required for each color.

The equipment is simple. You need a screen consisting of a rectangular wooden frame with organdy stretched across it, a smooth printing base or board upon which to set the card or other article on which the design is to be printed, and a rubber squeegee for pushing the paint through the screen. Papers, paints, solvents, and other supplies can be found at most art-supply stores.

A sturdy drawing board, a smooth table, or any flat surface will serve as a printing base. If there is an old window wiper handy, you need not buy a regulation squeegee, for it will work just as well. The purpose of the squeegee is to force an even coat of paint through the screen so that an equal amount of it will reach all parts of the design being printed. A customary method of quantity printing with a silk screen is to pour a sufficient amount of paint on the screen, push it across with the squeegee to print one card, push it back to print the next, and thus alternate each time, renewing the supply of paint when necessary.

Make the wooden frame with strong, square corners, using any corner joint that you prefer and bracing it with angle irons if necessary. As long as it is rectangular, it can be of almost any dimensions, but 14" by 20" will be found a good size. If you wish, you can make more than one frame and have an assortment of sizes.

Stretch a piece of organdy across the frame to serve as a screen or ground for holding the stencil in a fixed position, tacking it tightly to the frame all around. This completed unit is known technically as the screen. The use of organdy, incidentally, was not developed as a wartime substitute and should not be considered a makeshift arrangement. When silk-screen printing was young, only silk was used, and this gave the process its name, but later on, while silk was still plentiful, other fabrics, among them organdy, also came into use and proved equally popular.

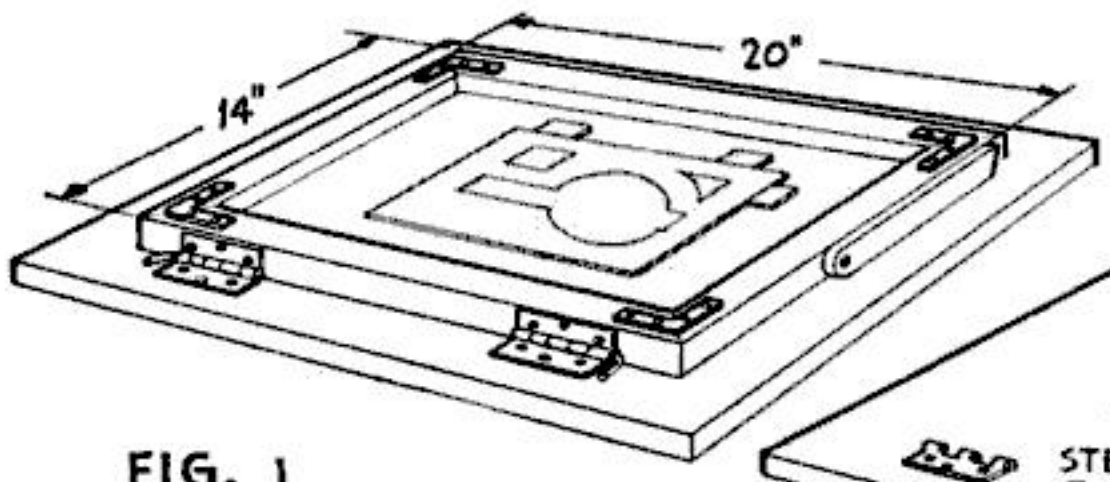


FIG. 1

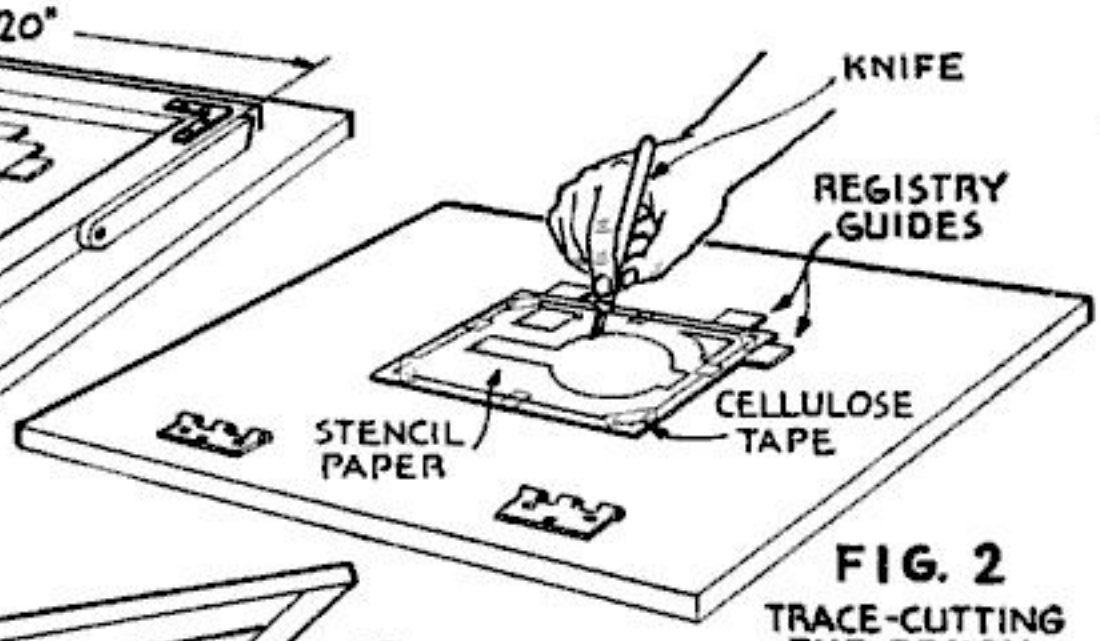


FIG. 2
TRACE-CUTTING THE DESIGN

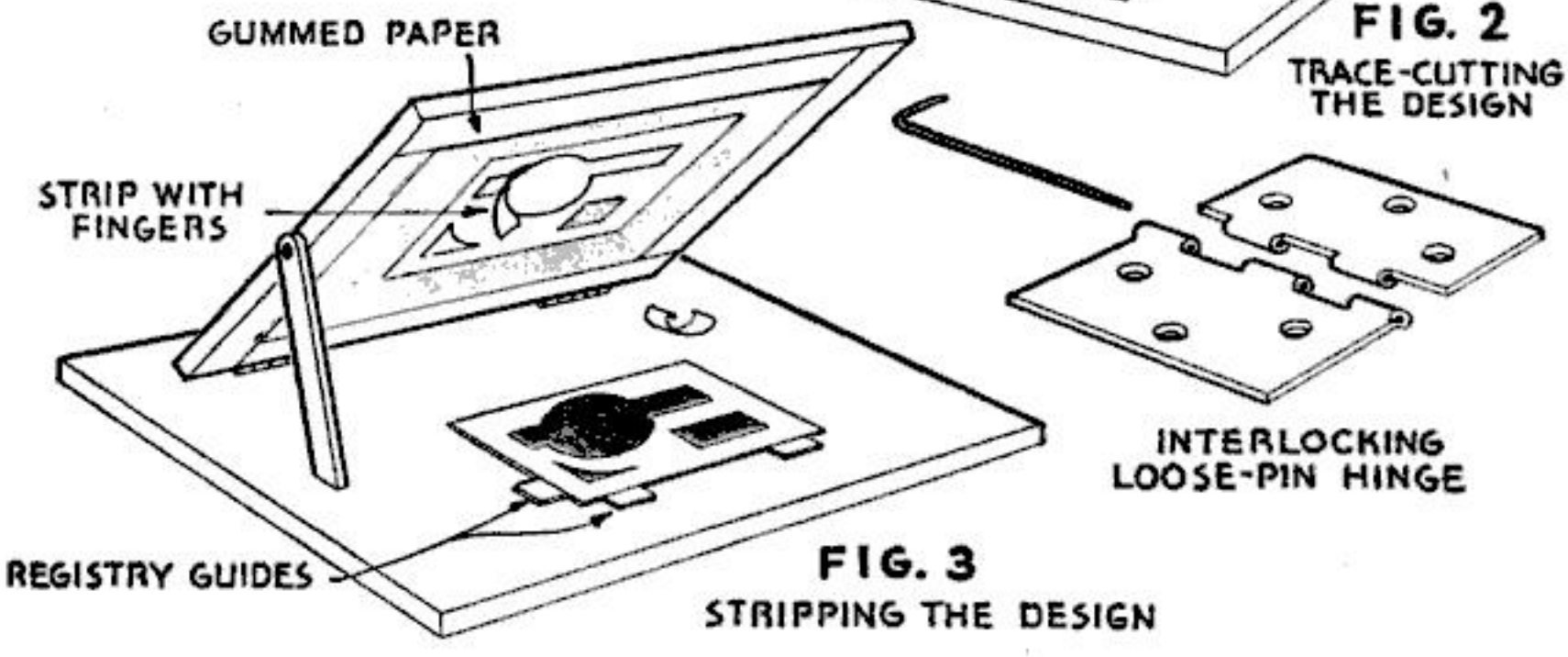


FIG. 3
STRIPPING THE DESIGN

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Hinge the completed screen to a printing base so that it may be raised and lowered into the same place for each screening. Hinges having removable pins will permit detaching the screen from the base when necessary, and also will allow substitution of another screen when desired. A 6" strip of wood held to the side of the frame with a single nail as a pivot will be helpful in propping up the screen so that your hands will be left free for removing prints from the base and for inserting fresh cards.

This silk-screen outfit is permanent equipment that will not have to be replaced for each new project. The same unit, properly cleaned, can be used for dozens of different jobs. With it you can print on any reasonably flat surface, and that includes such diverse materials as paper, leather, cardboard, wood, glass, linoleum, and textiles.

Before taking up the preparation of stencils, it is well to look into how silk-screen craftsmen handle the problem of register. In a one-color job this is not quite as important a problem as in work with two or more colors, for then care must be taken to print each color in alignment with every other color.

Here is a foolproof method of color registration. The card to be printed is centered on the printing base, like a picture in a frame, with the sides of the stencil frame as the limiting boundaries as shown in Fig. 1. Cardboard register guides are then tacked in position along the sides of this card. They fix the position of every succeeding card inserted for the printing of that particular design and are not altered or reset until all the colors have been printed on all the cards for this job.

There are five main ways of making stencils, but one—the photographic method—is fairly complicated for the beginner and will be omitted here.

Most elementary is the paper stencil, which may be prepared from a sheet of tracing paper or ordinary bond paper. Lay this paper over the picture or decoration to be reproduced while the latter is centered on the printing board between the registry guides and fasten it with adhesive tape; then trace the lines desired with a sharp



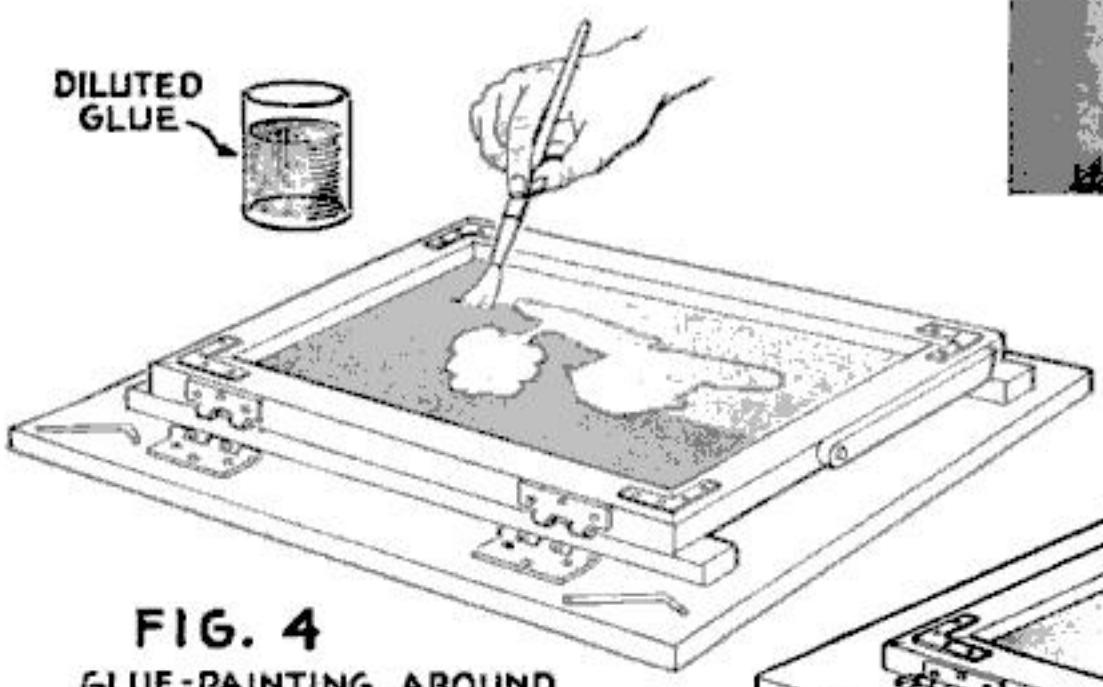


FIG. 4
GLUE-PAINTING AROUND THE DESIGN

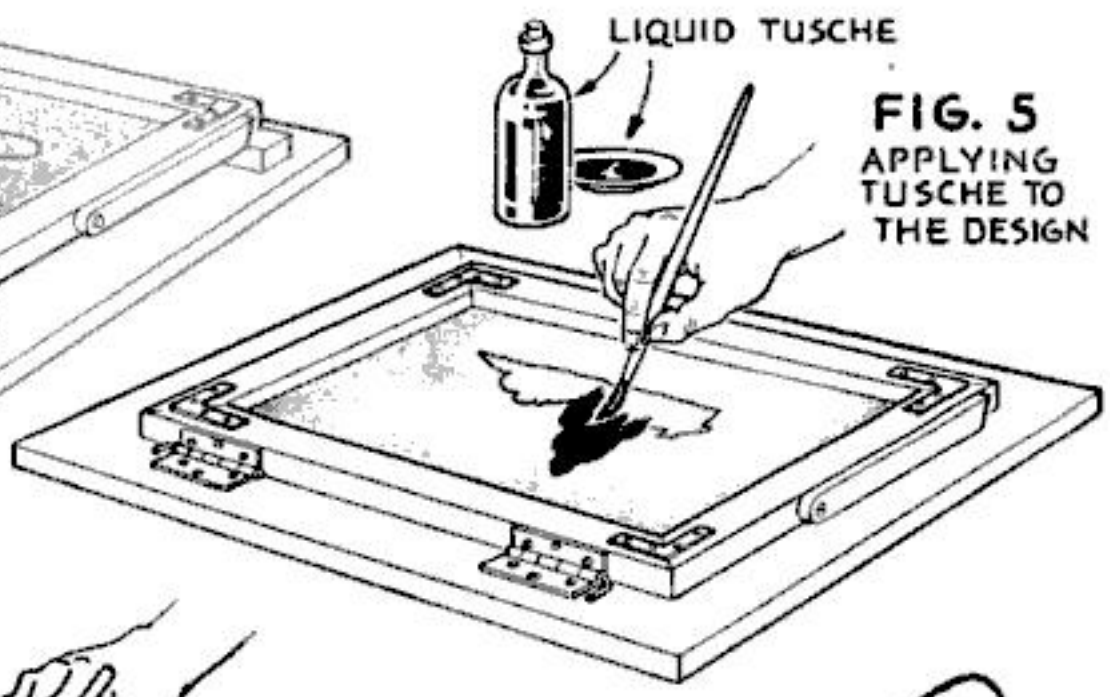


FIG. 5
APPLYING TUSCHE TO THE DESIGN

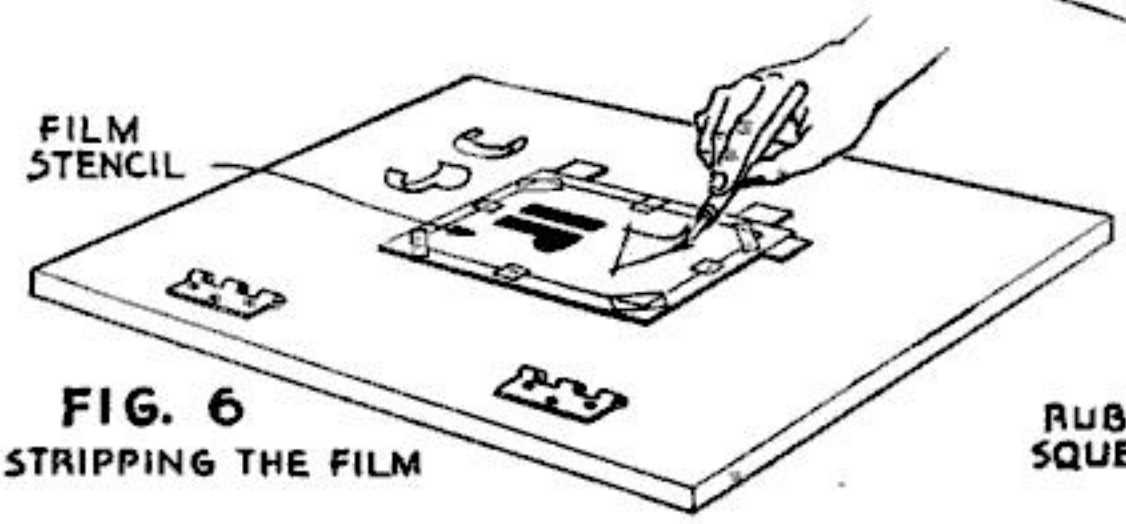
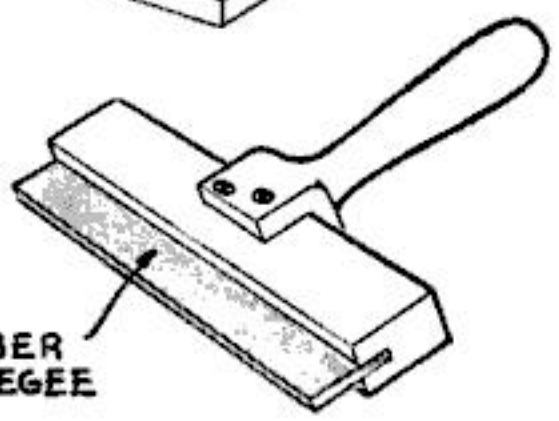


FIG. 6
STRIPPING THE FILM



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knife, preferably a stencil knife, as in Fig. 2. Remove the tape carefully so as not to shift the tracing paper, and then lower the screen into place. The paint that is to be used in printing is put on the screen and spread over it with the squeegee. This adheres the stencil to the screen, after which it is a simple matter to raise the screen and peel off those parts of the stencil that are to be left open for printing the design, as shown in Fig. 3.

The card to be printed is then placed on the printing board after the original has been removed, and the printing is begun, paint being spread over the screen with the squeegee. Silk-screening paint, with either an oil or water vehicle, is obtainable at artists' supply houses. When you have made as many cards as desired, or have finished them all with the first color of a multicolor print, scoop up the paint remaining on the screen and peel off the stencil. The screen can then be washed with kerosene-soaked rags, after which it will be ready for a new stencil.

If hundreds of copies are to be printed, a block-out stencil will prove better than paper. Glue, diluted with 3 parts water, is used to block out those parts of the screen that are not to be printed. Lacquer or shellac can be used instead of glue, however, and are necessary with water colors so that the paint will not dissolve the stencil.

Lay the screen over the model and trace the desired lines on the organdy with pencil or ink. Remove the original from the base, lower the screen, and then block out the parts that are not to be printed, applying the glue or other medium with a paint brush, as in Fig. 4. Allow plenty of time for drying—at least an hour for glue, less for shellac or lacquer—and proceed with the printing the same as when using a paper stencil.

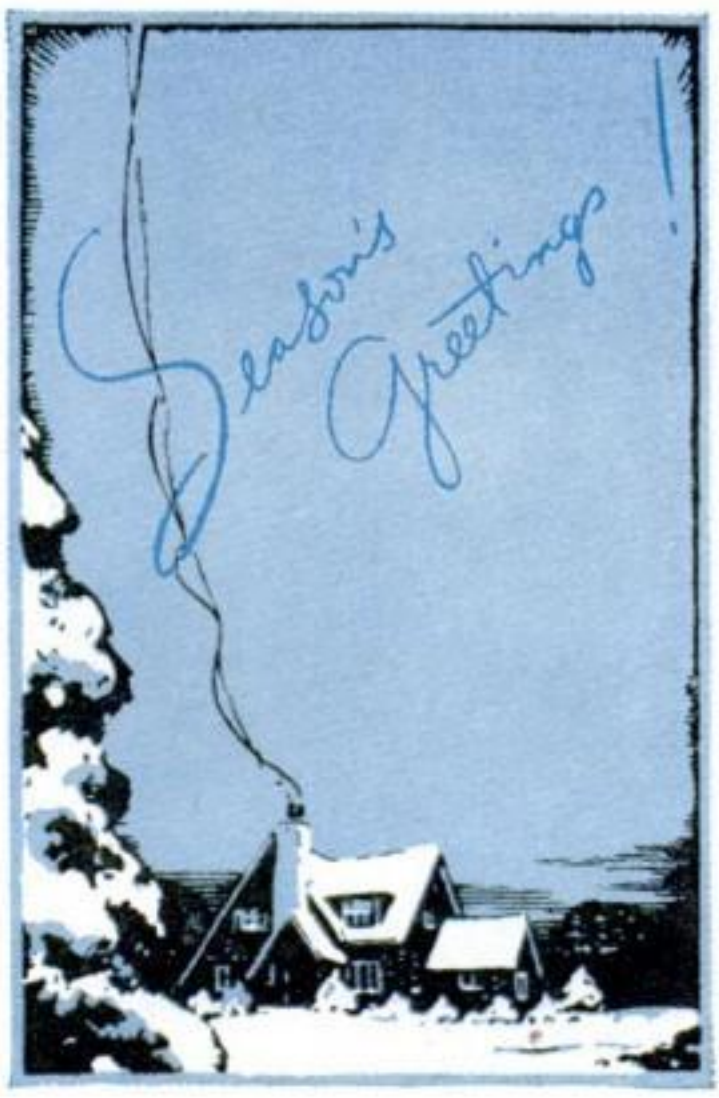
When the screen is to be cleaned, if glue has been used, just sponge it with warm water to dissolve the glue, washing both sides of the organdy. Lacquer thinner or alcohol is required for the other mediums. Be sure to allow the screen to dry thoroughly before putting it away.

Lithographer's tusche, used with glue, forms the basis for still another stencil. Unlike the other methods, the tusche, which is a greasy substance either in liquid or crayon form, is applied to the screen *within* the outlines of the design to be reproduced, as in Fig. 5, instead of *outside* them. Any mistakes in design may be washed out with water while the tusche is still wet, or with kerosene after it has set. If the picture being copied is valuable, a tracing of it may be used as a model to keep tusche from seeping through the screen onto it.

Prop up the screen after applying the tusche, or remove it from the hinges and place it on blocks, and then spread glue over it with a piece of cardboard. If not free-flowing, the glue may be thinned with water. When the glue has dried, that over the tusche foundation will be scaly and can be easily broken away and removed, along with the tusche, with a kerosene-soaked rag, leaving the necessary open sections in the stencil for printing.

Tusche may be made to give a variety of textural effects. In the liquid form it may be applied with an atomizer, air brush, toothbrush, or comb, or it may be stippled, spattered, or cross-hatched. The soft, sketchy lines of the crayon may be accented with the liquid tusche to bring out high lights or to add depth.

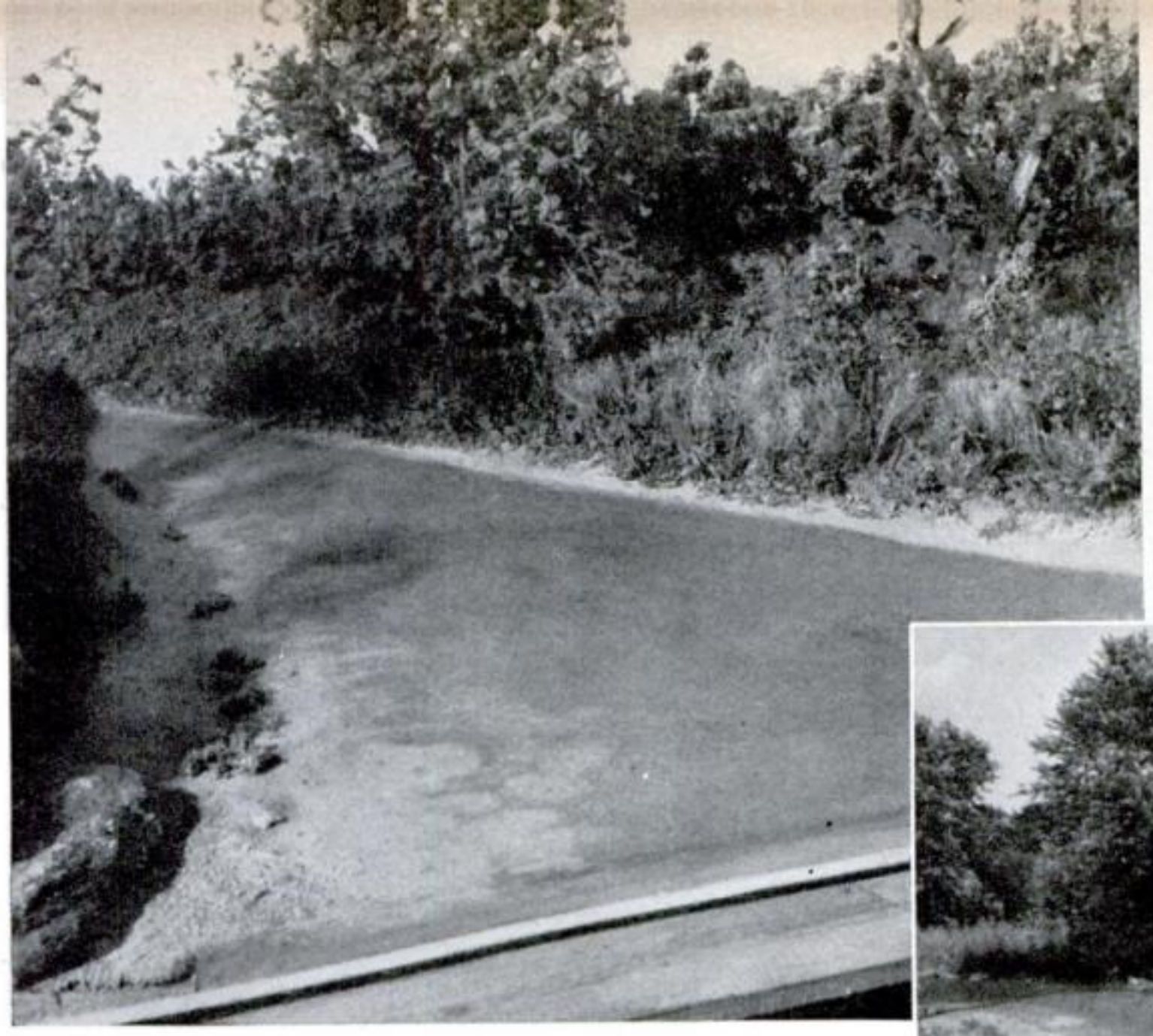
Finally, there is a special film-stencil paper that is often preferred when printing is to be done in the thousands. This special paper, which can be obtained from art-supply dealers, is a glassine sheet lacquered on one side. The film is laid, lacquer side up, over the picture to be reproduced and is fastened at the corners with adhesive tape. Then the design is cut with a stencil knife, but just through the lacquer, not through the glassine paper, and the cutout parts are stripped off, as shown in Fig. 6. Examine the open areas and brush off any stray particles of lacquer that remain.



Now lower the screen and apply a little lacquer thinner with a soft, folded cloth to a small area at a time. Rub it with a dry, clean cloth, working more briskly as the thinner dries. This adheres the lacquer to the screen so that the glassine paper can be pulled away. Open places are thus left in the lacquer stencil through which the paint will print.

A stencil of this kind is practically imperishable and can be stored with the screen indefinitely if you wish to preserve it for further use, or it can be dissolved away.

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Which is the real scene and which the model-rail layout is hard to tell in these photos. The landscape at left, built up from dried twigs, sawdust, and sponge rubber, is almost a duplicate of the real scene shown below. Many natural views are possible in making your pike realistic in every detail



MINIATURE TREES

ADD LIFE TO YOUR MODEL PIKE

By Carl W. Bertsch

TREES are often a headache to the model builder concerned with reproducing nature in miniature. One successful but tedious method of making them is to fashion the skeleton — trunk and branches — from wire, use wax, plastic composition wood, or papier-mâché to build up the larger trunks, and then glue the leaves on laboriously. The leaves can be made of paper, bits of sponge rubber, or slices of natural sponge.

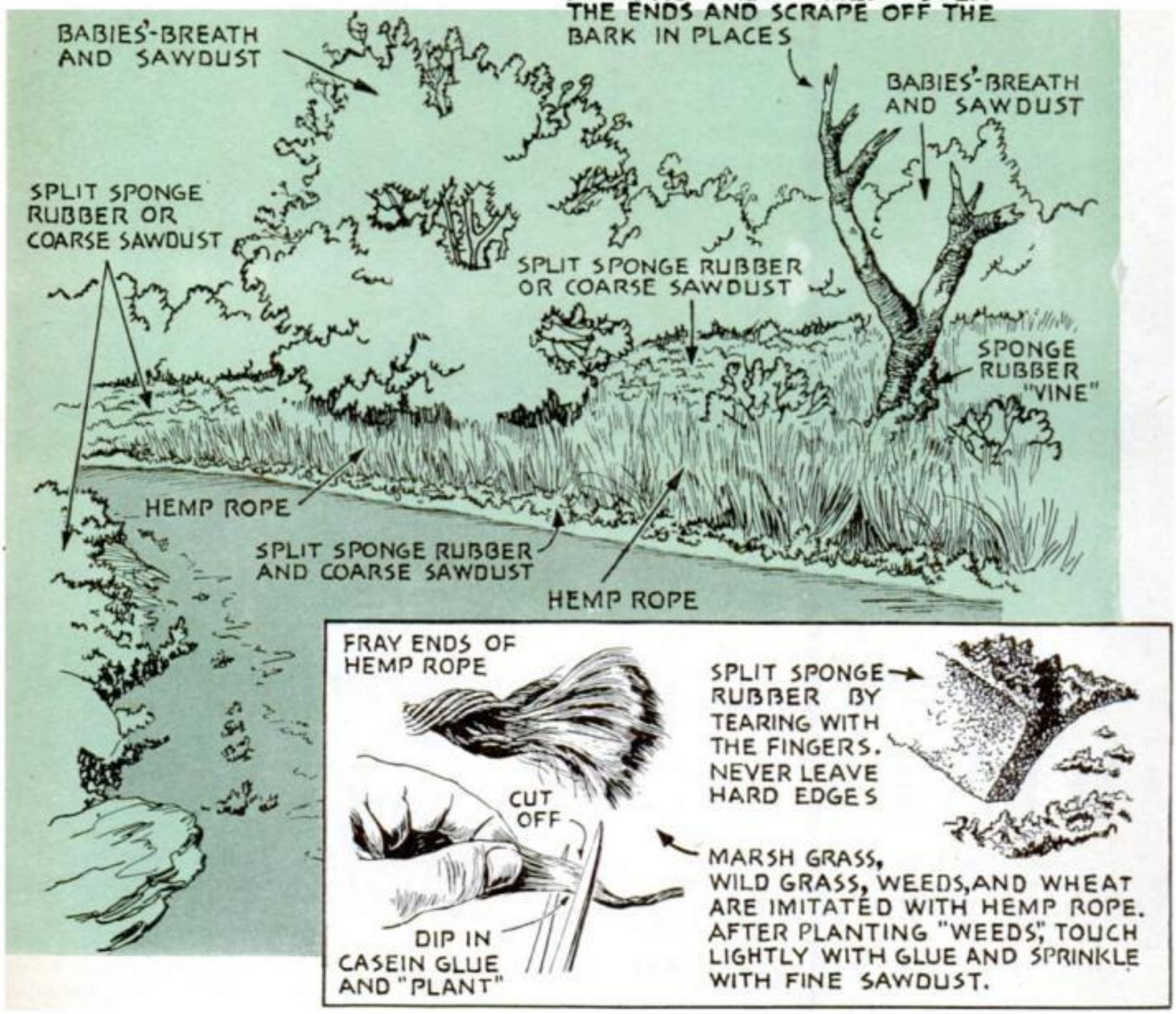
For a large tree of a particular type dominating the foreground of a three-dimensional picture, this method is still the best. The time and labor spent are well worth while for one or two trees. But when many trees are to be built on a large slice of countryside, some other method must be used.

I have found that going to nature for my skeleton, the tree structure, has produced gratifying results. Babies'-breath, *Gypsophila paniculata,* an old-fashioned garden flower, when dried with its flowers, can be used to imitate almost any type of wide-branching tree. Bunching individual stems and winding them with brown or black carpet thread is a mass-production method far more realistic than any other I have known or used. Dried babies'-breath can be purchased at the larger artificial-flower stores in natural color or dyed green. I prefer it dyed.

What might be an elm with a bush near its base is shown in the photograph on page 163. Both were made from dried babies'-breath. The diminishing scale of the other trees in the photo indicates some of the possibilities. With its flowers attached, you have without further preparation trees just breaking into leaf in spring. For summer and fall foliage, leaves must be added. The most satisfactory material for this is ground sponge rubber. It is now difficult to obtain, but old chair-seat cushions made of sponge rubber are still to be found.

Cut the rubber with scissors into ½"

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pieces and run them through a kitchen meat grinder, using a medium-fine cutter. Prepare a thick mix of casein glue in a large bowl, and dip the ends of your trees into this and then into the granulated sponge rubber. Next, apply glue to the inner surfaces and sprinkle on more granules. The result will be a well-leafed tree.

Sawdust, coarse and medium-fine mixed, is the next best material for leaves. Instead of dipping the branches, sprinkle the sawdust on. Sawdust with its finer particles is even preferred to sponge rubber for distant groupings.

After preparing a heavy-foliaged tree with either of these materials, hang it top down on a line, gently squeeze the branches together, and leave it to dry. If it is allowed to dry upright, the weight of the leaves will make the branches droop.

In woods viewed from a distance, the trunks of trees rarely show, and even single full-leafed trees show little trunk, so plant these trees as low in the ground as the branches will permit. You will find that you need fewer trees to achieve density. Always plant bushes low.

A 10" tree is 40' high on a scale of ¼" equals 1', high enough for model-railroad requirements. If a tree of this size is heavily leafed, it may be necessary to support the branches by circling them with fine black thread, which is not readily visible.

Firs, pines, Lombardy poplars, and weeping willows cannot be imitated successfully by mass-production methods, but must be built up of wire, as shown in a drawing, except for distant background. Fir and pine forests are best painted on backgrounds, the mass-produced trees leading up to within 1" or 2". This air space creates the illusion of terrain dipping downhill to rise again in the distance.

Lombardy poplars and cone-shaped firs can be simulated from sponge rubber if they are on a small scale in the distance. Avoid

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clipped, formal-garden effects, and strive to imitate nature from your photographs.

Many herbs, wild flowers, grasses, dead twigs, and small roots will contribute to your completed landscape.

Coloring your miniature countryside is the final step. Critically observe the woods and fields, and you will discover that no two trees, bushes, or patches of grass are exactly the same shade. In the distance are blues, lavenders, and purples; nearby trees are green tinged with yellow, brown, blue, and purple, grasses and weeds run from pale green to yellow, red-brown, and purple-brown, and ivy and wild vines are blue. Even the bare earth is red, yellow, brown, and bluish. Your sponge rubber and sawdust can be tipped with a multitude of colors to represent wild flowers.

Artist's tube oil colors, studio size, are the best to use. These may be sufficient:

Ivory black	Burnt umber
Prussian blue	Raw sienna
Ultramarine blue	Burnt sienna
Cobalt blue	Yellow ochre
Cerulean blue	Golden ochre
Cobalt violet	Cadmium yellow, medium
Permanent green, light	Cadmium yellow, pale
Permanent green, medium	Cadmium orange
Permanent green, dark	Harrison red
Raw umber	Cadmium red, light

To these add a 1-lb. tube of zinc white.

Thin the colors well with pure turpentine. Use 1" artist's bristle brushes for general terrain, smaller brushes for tipping flowers and vines. Trees should be sprayed with an artist's airbrush designed for oil colors or a good spray gun, never a standard retoucher's airbrush.

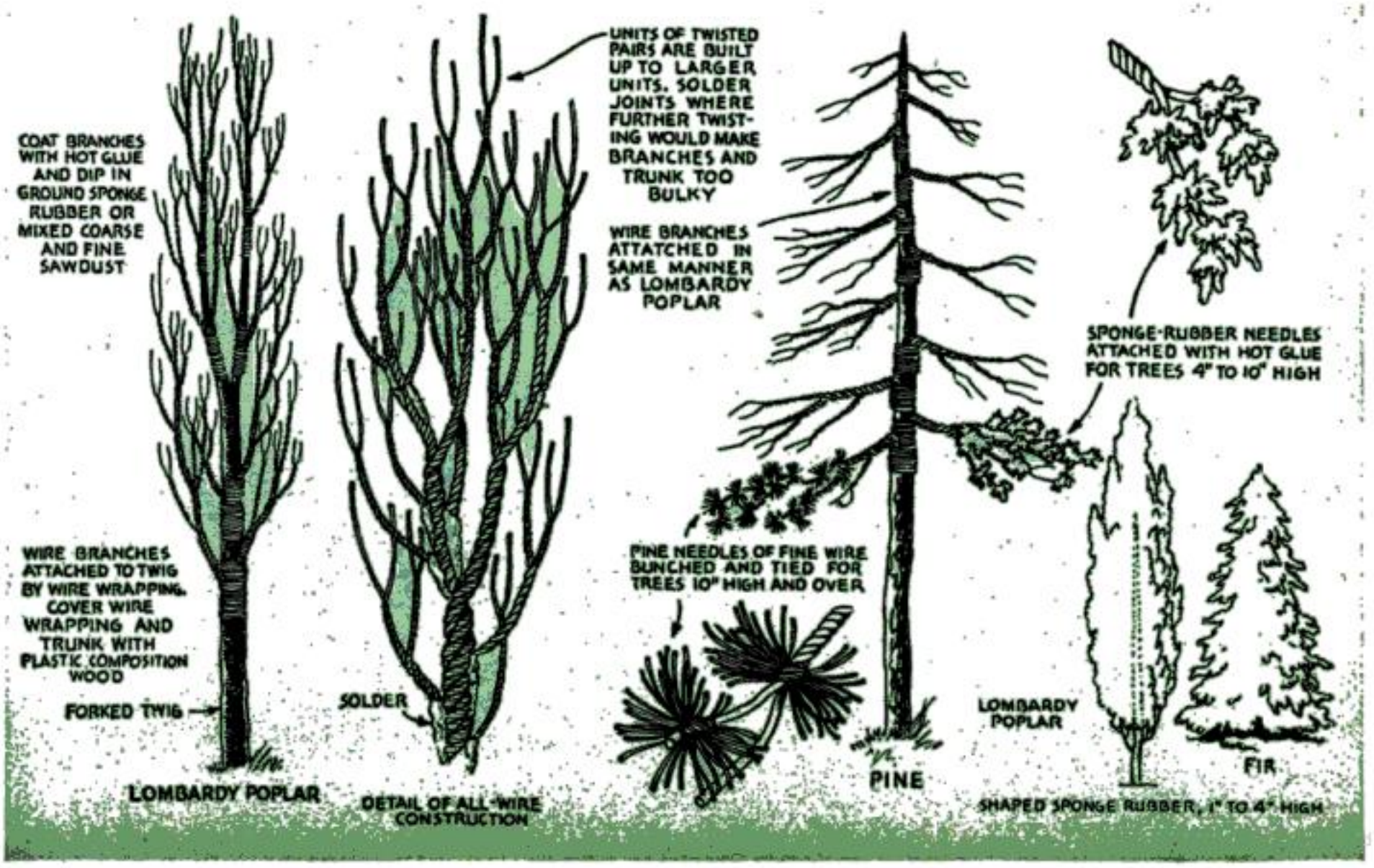
Be wary of flat backgrounds unless you are a landscape artist. Your safest bet is simply sky, possibly with interesting patterns of clouds. Remember that the blue at the horizon is lightest. If your pike is brilliantly lit, then your sky and clouds must suggest bright sunlight.



These trees are made from dried flowers. Their diminishing scale will add distance to a landscape

Have a definite sunlight source when painting clouds. Pale pink and yellow, accented by pure white on the sun side and light grayish blues and lavenders on the shade side, will give clouds three-dimensional quality. Keep them light in color unless you prefer rain or storm clouds.

And last, paint your whole layout—scenery and sky—under the light you intend to use in running your railroad.



SPRING FURNACE REPAIRS

By John Modroch

WHEN is the best time to service a furnace? Obviously not during the heating season, for many parts cannot be taken out, or even reached, until the furnace is shut down. Many wise householders get at the annual furnace job in the spring, as soon as the last need for heat has ended. Thus they assure maximum protection against corrosion of exposed metal and also have time to order replacements.

Don't drain a steam boiler for the summer; it is better to keep it filled to prevent rusting and to avoid the need for "conditioning" fresh water in the fall. Stale water, containing less air, is a better heat retainer and is less corrosive than fresh water.

Since the cleaning of a heating unit is begun at the top to prevent the settling of soot and scale on parts previously serviced, begin by checking the smoke pipe, which should be taken down and emptied of soot. After a thorough cleaning, protect it from summer dampness with a coat of hot-pipe aluminum paint or some other metal paint.

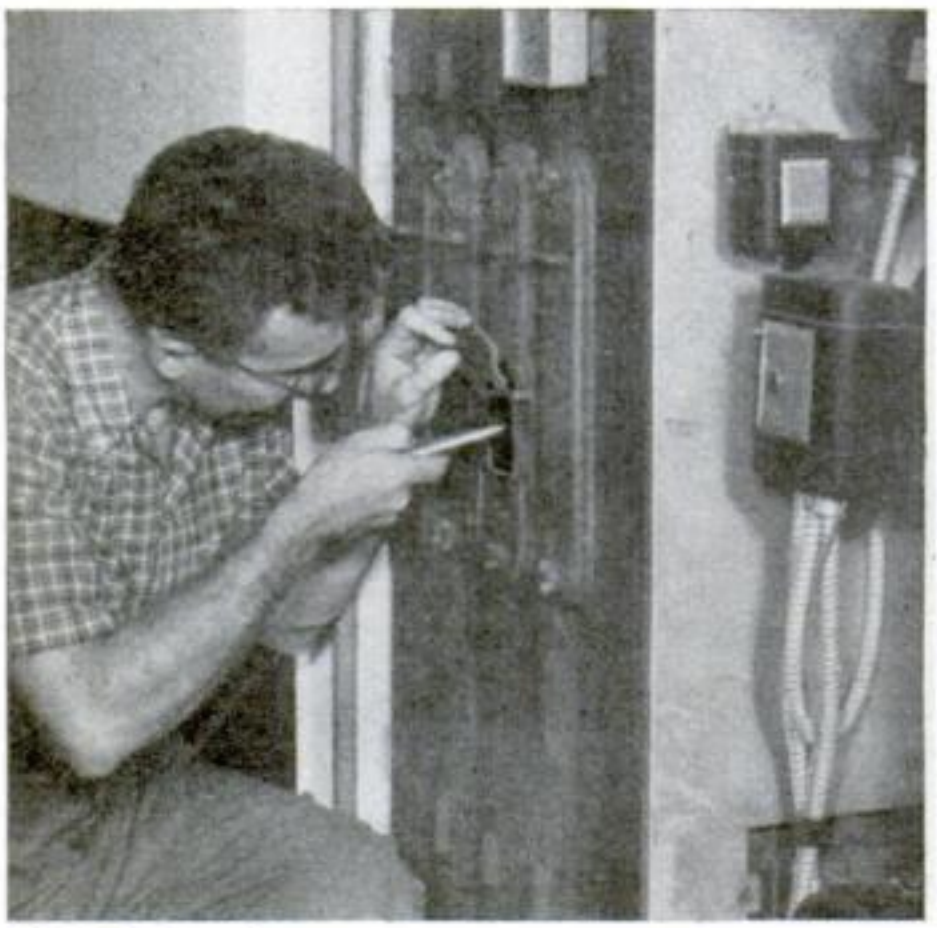
When ordinary hard coal is used, soot need be cleaned out only once a year, while an oil-burner smoke pipe may need attention only every two or three years. The pipe of a stove burning green cord wood may require cleaning every month or so, and if trash is burned in a furnace in the summer, the pipe will need another cleaning before it is fired in the fall.

During reinstallation of smoke pipe, make the joints airtight where the pipe enters the chimney and where it fits into the smoke head of the furnace or stove. Furnace putty or some fireproof plastic compound is an excellent sealer, or a mixture of 1 part Portland cement and 3 parts asbestos may be used. Snug-fitting chimney thimbles and collars are also a help.

Make sure the chimney flue is also airtight by closing the clean-out door of the soot pocket in the flue below the smoke-pipe opening, and by sealing with tight-fitting flue stops any other pipe openings in the cellar or on the floors above. If the prongs of a stop fail to hold, spring them slightly.

Near the top of a hot-air furnace, a clean-out door leads into the heat-dispersing chamber. There are several such doors on some steam and hot-water furnaces, each affording access to a section of flue passage. Scrape or brush the ones at top first and work down. Some persons use a vacuum-cleaner hose after removing the hard scales and most of the dust.

If the fire pot has a lining, examine it for breaks. This is particularly necessary in a deep fire pot where fresh coal, fed to the top of the bed, must settle a considerable distance before it reaches the grate. Lining



CRACKS in some boiler sections can be seen through a peephole with the help of a flashlight



FLUE PASSAGES are cleaned with a wire brush to remove soot and scale that cut down heat

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INSURE YOUR WINTER COMFORT

that is pitted will keep the bed from settling level by holding the sides suspended, and this eventually causes the formation of clinkers around the edges and limits the fire to the center portion.

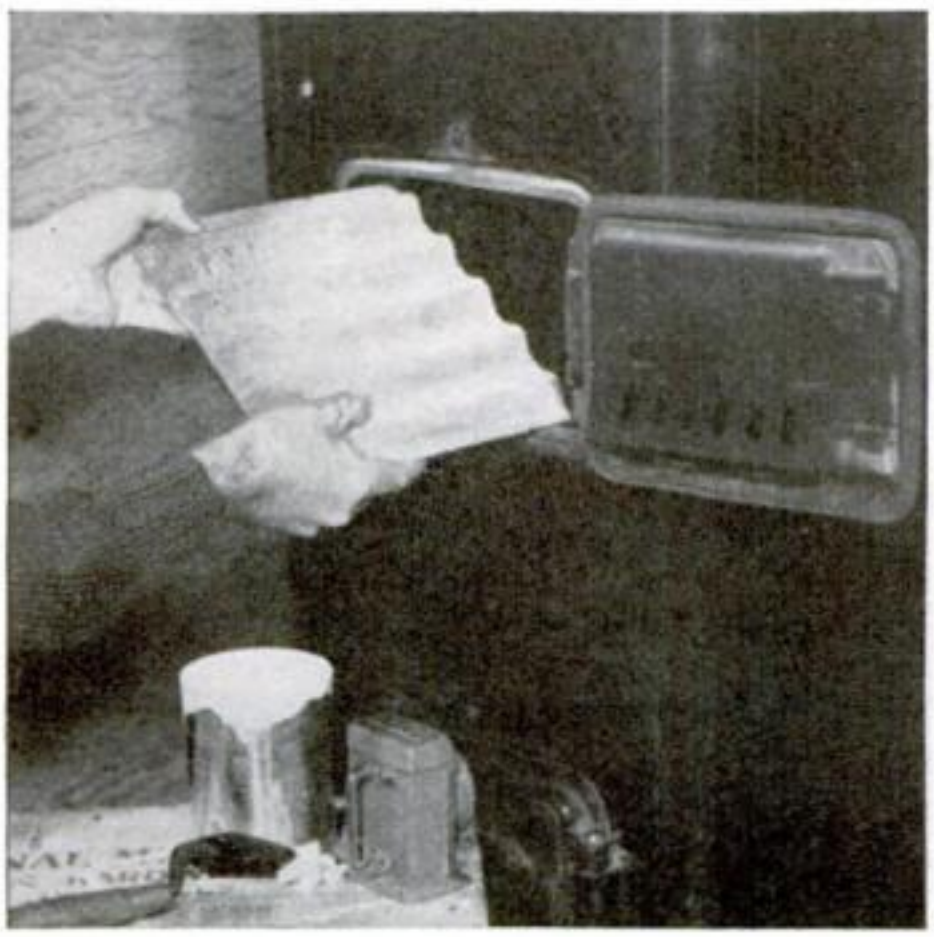
Firebrick lining should be pried from a burned section, and new bricks, soaked in water before being fitted, laid with just enough fire clay to point up the edges. Fire pots designed for replaceable cast-iron linings are equipped with cleats or similar devices to hold the sections in place.

Small breaks in the filler that seals the joints between the fire pot and other castings can be closed with furnace putty or fire clay when the furnace can be shut down for a day or two to give the material time to set. If the joints are in very bad shape, call in an experienced repairman to take the castings apart and reset them.



WATER GAUGES can be cleaned when the furnace is in operation with an acid solution drawn up by vacuum action

Leaks in a boiler section, sometimes caused by uneven expansion when a cold furnace is fired too fast, can be stopped in some cases by a prepared commercial sealer poured into the boiler as directed by the manufacturer. Leaks at the joints between sections can usually be stopped by turning down the nuts on the boiler tie rods to draw the sections together. *Be sure to turn the nuts back again to their original setting;* otherwise

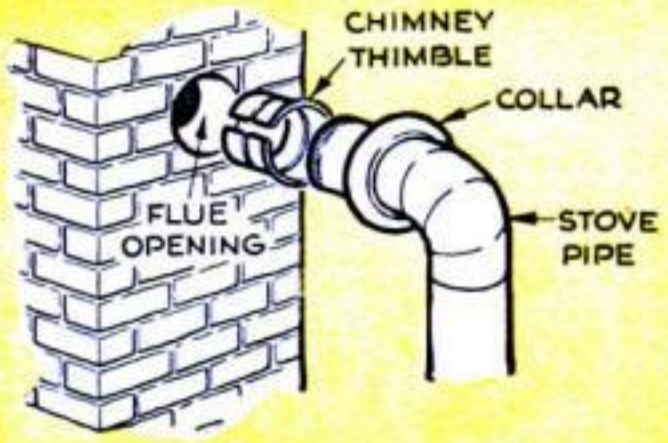


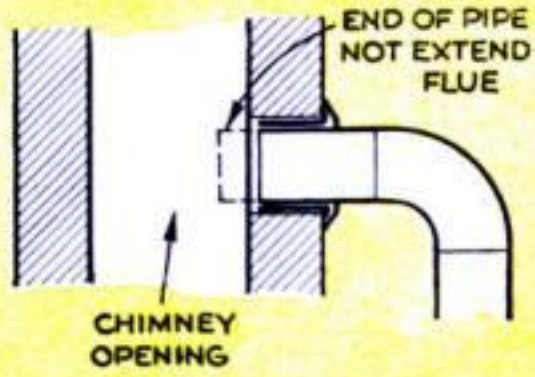
FIRE-POT LININGS of firebrick should be removed when burned out and replaced with new bricks

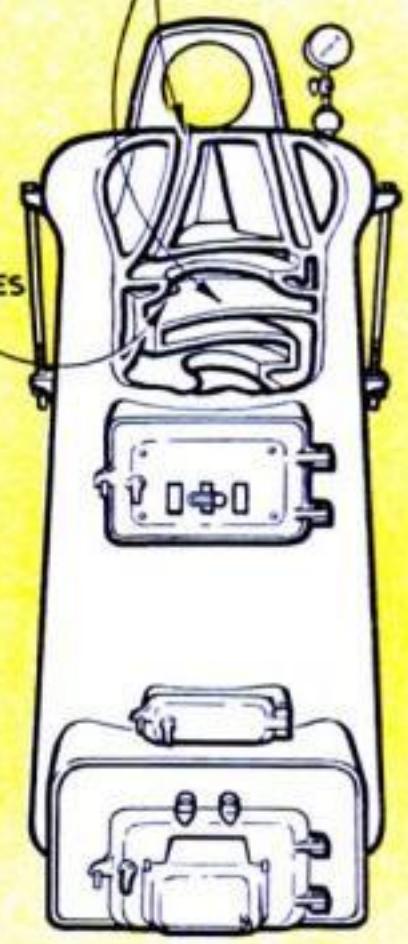


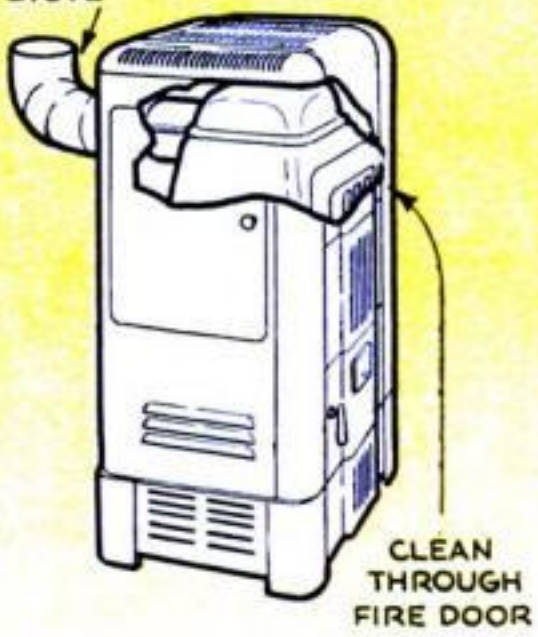
LEAKY JOINTS are stopped by tightening the tie-rod nuts and then turning them back again

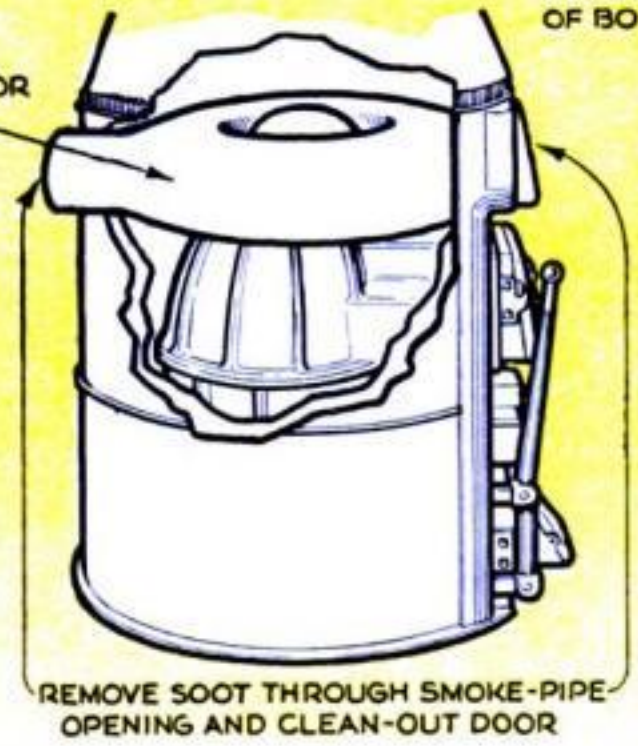
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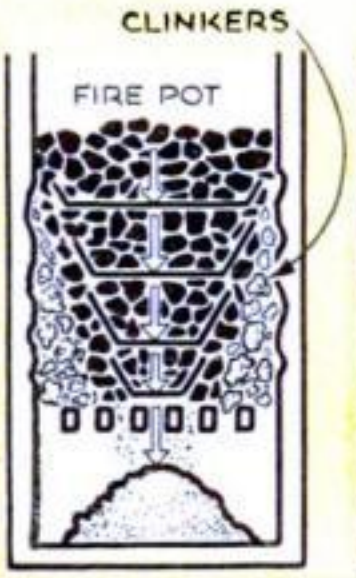




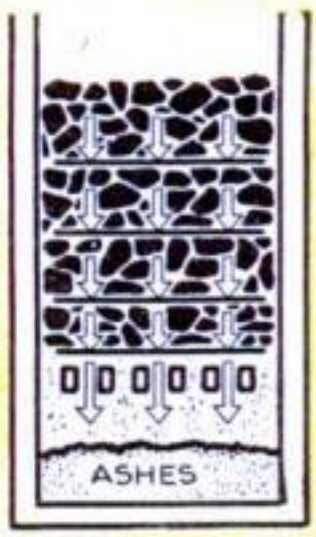








ROUGH LINING PREVENTS FUEL FROM SETTLING EVENLY. FIRE DIES OUT

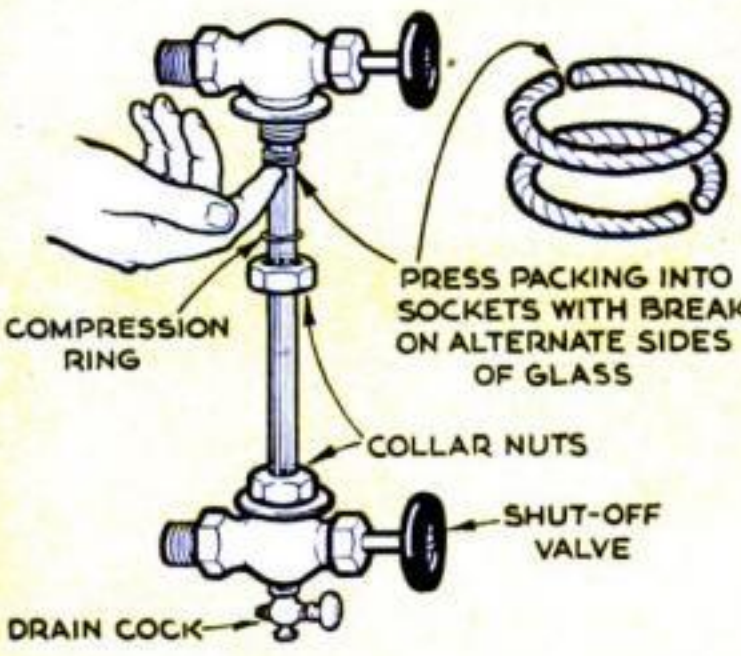


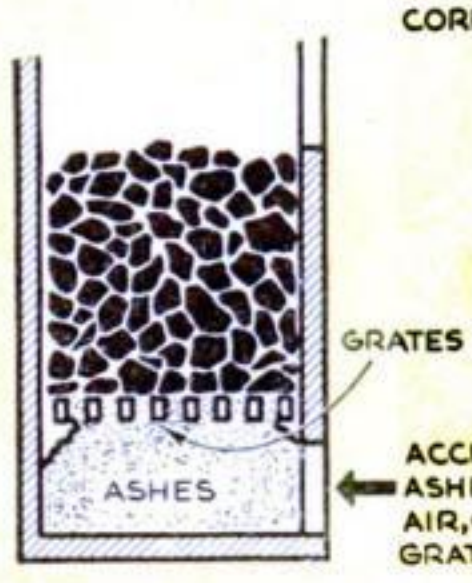
SMOOTH LINING ALLOWS BED TO SETTLE EVENLY AS FUEL BURNS



FIRE BRICK LINING IN ROUND FIRE POT OF FURNACE









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further expansion may break the rods or lugs or crack the sections. It is *normal* for the tie rods to be *loose* and the nuts *finger-tight* when the boiler is cold.

Dirt and scale should be scraped from warped doors, and the high spots then filed down so the entire rim will seat flat against the frame. A sheet of paper may be used for a test of the fit as shown in one of the drawings.

In inspecting the grate, manipulate the shaker handle or crank and observe the action through the fire door. Never force a shaking mechanism, for you may cause more trouble. If the metal has not been burned away, clean breaks in a grate can usually be repaired by welding. Failure to empty the ashpit allows ashes to bank up, shutting off air that protects the grate from overheating, and is a common cause of damage.

To replace a broken water-gauge glass, remove the guard rods, or the front panel of the furnace if it serves as a cover; then unscrew the collar nuts at the top and bottom of the glass, lift out the broken ends and the compression rings, and scrape out the old gasket or packing. The new glass should be cut about $\frac{5}{8}$" longer than the distance between sockets. Slip a compression ring and collar nut on each end of the glass, and insert one end into the bottom socket. By pushing it all the way, you can bring the other end into position. Then lift the glass enough for both ends to extend equally into their sockets, and fill the space around the ends with a packing of rings cut from graphited cord or a wrapping of soaped string. If the latter is used, wrap it around the glass in the direction in which the nut will turn when tightened. Don't use too much packing, tighten the bottom nut first, and don't tighten too hard, or you may break the new glass.

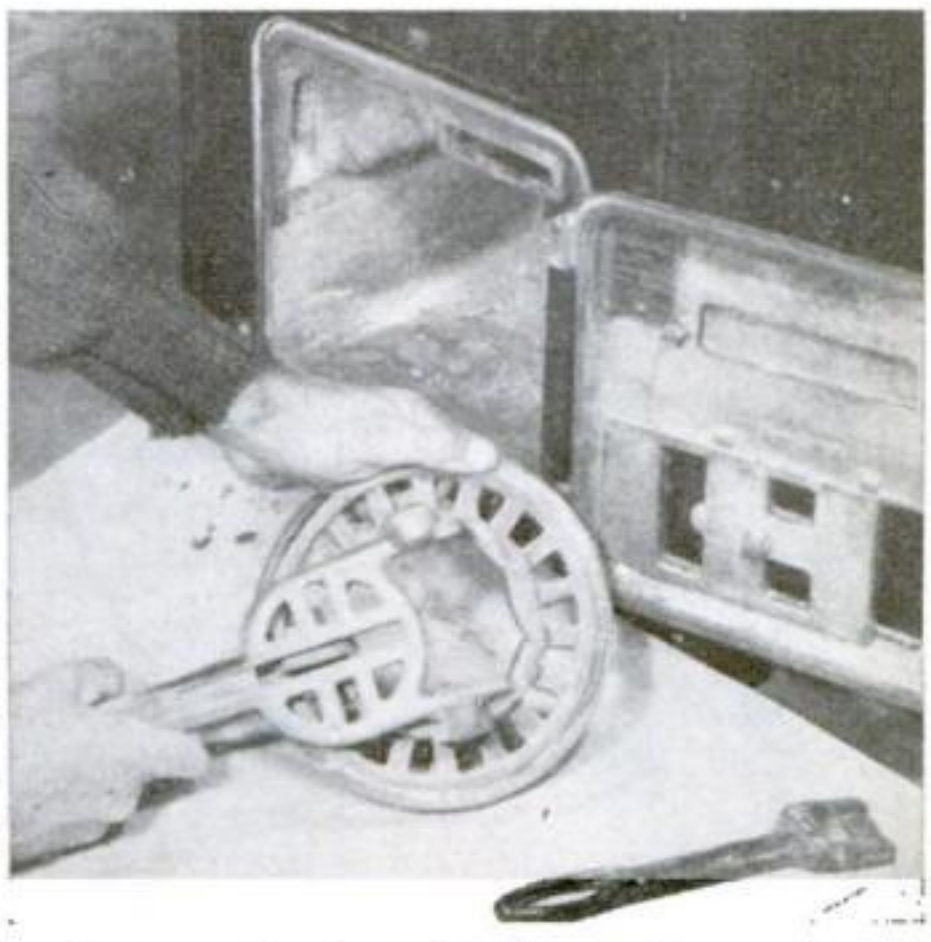
If a broken glass cannot be replaced immediately, shut the valves above and below it. The height of the water can be tested by turning the try cocks. Water should run out of the bottom, and the middle, if there should happen to be one, but not from the top cock.

A water-gauge glass can be cleaned with a tablespoon of raw muriatic acid in a cup of hot water while a furnace is in operation. Handle the solution carefully to avoid splashing it on your clothes or skin. Close the bottom valve, and blow the water out of the glass by opening the drain cock. Then close the top valve very quickly and submerge the drain cock in the acid solution at once. The vacuum thus created will draw the solution into the glass. Keep the drain cock submerged, and open and close the top valve, expelling and drawing up the solution, until the glass is clear. Then close the drain cock and open the top and bottom valves again.

When ordering replacements, give your dealer all the information he requires. It should include the manufacturer's name, the serial number or size and type of stove or furnace, and a description of the part and its pattern number. Look for the name plate containing the serial number on the inside of the clean-out or ashpit door. The pattern number is cast on each part.



Warped doors should be cleaned, scraped, and filed on the high spots until they fit flat; otherwise they let in air, spoiling your control of the fire

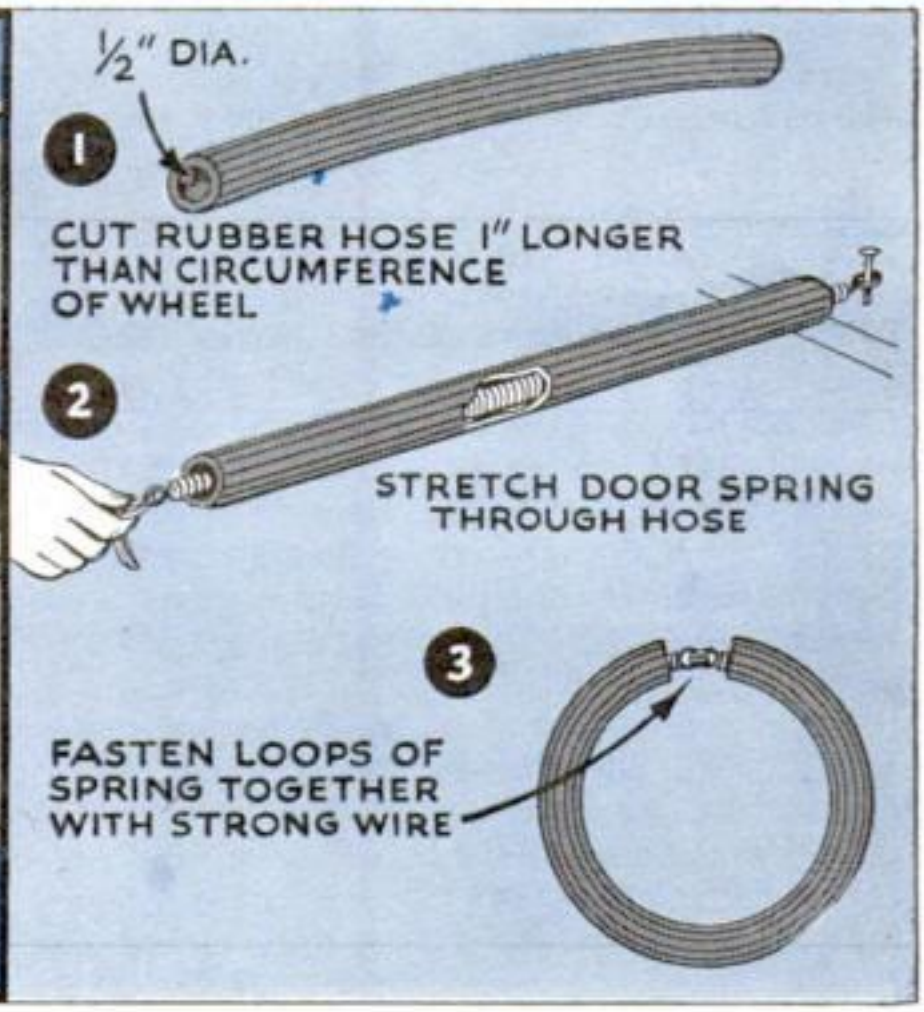


Grates require inspection for warping, cracks, and burned-out sections. A welding job will repair a clean break if the metal has not been burned away

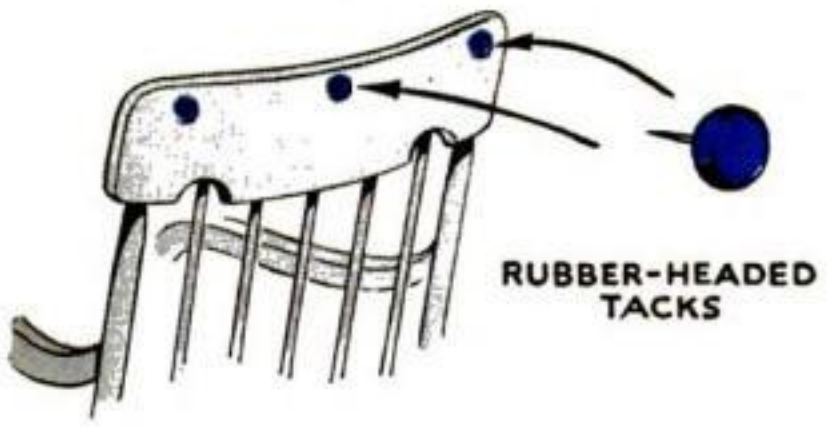
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KEEPING THE HOME





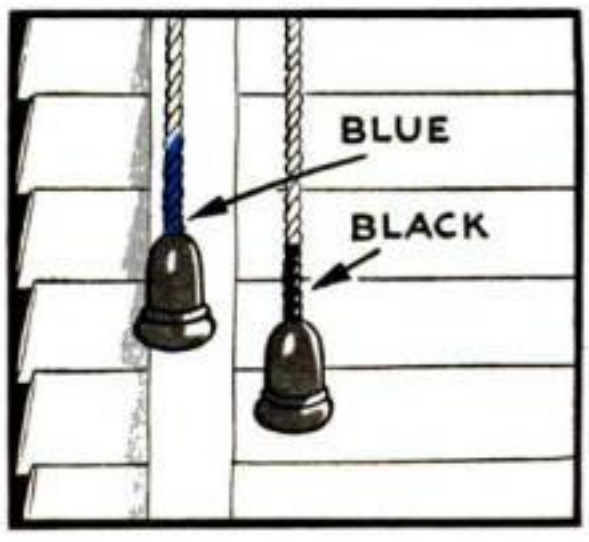
Auto-heater hose, or similar heavy hose of ½" to ⅝" inside diameter, and four ordinary door springs will give you a new set of tires for a baby carriage. Stretch a spring through each length of hose, as shown, and join the end loops with strong wire. Turn the hose occasionally for a new wearing surface



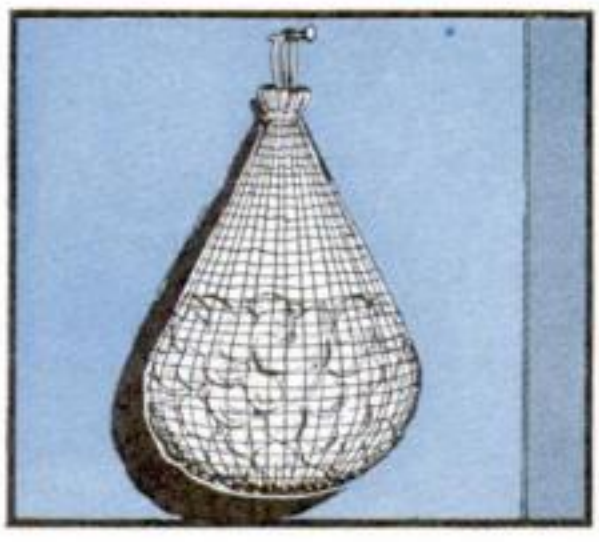
Two or more cushion tacks on the back of a desk, chair, or other furniture that is pushed against a wall keep paint or wallpaper from being marred



To prevent loss of small pieces of china, tiny lids, and the like during unpacking after moving, wrap these articles in the colored comic sheets



Bands of blue and black ink make easily distinguished guides on pull cords of Venetian blinds



Worn net curtains can be sewed into bags to hold stored onions. Run heavy cord through the hems



A soft cord threaded through the holes of records in an album may prevent breakage during a trip

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SHIPSHAPE

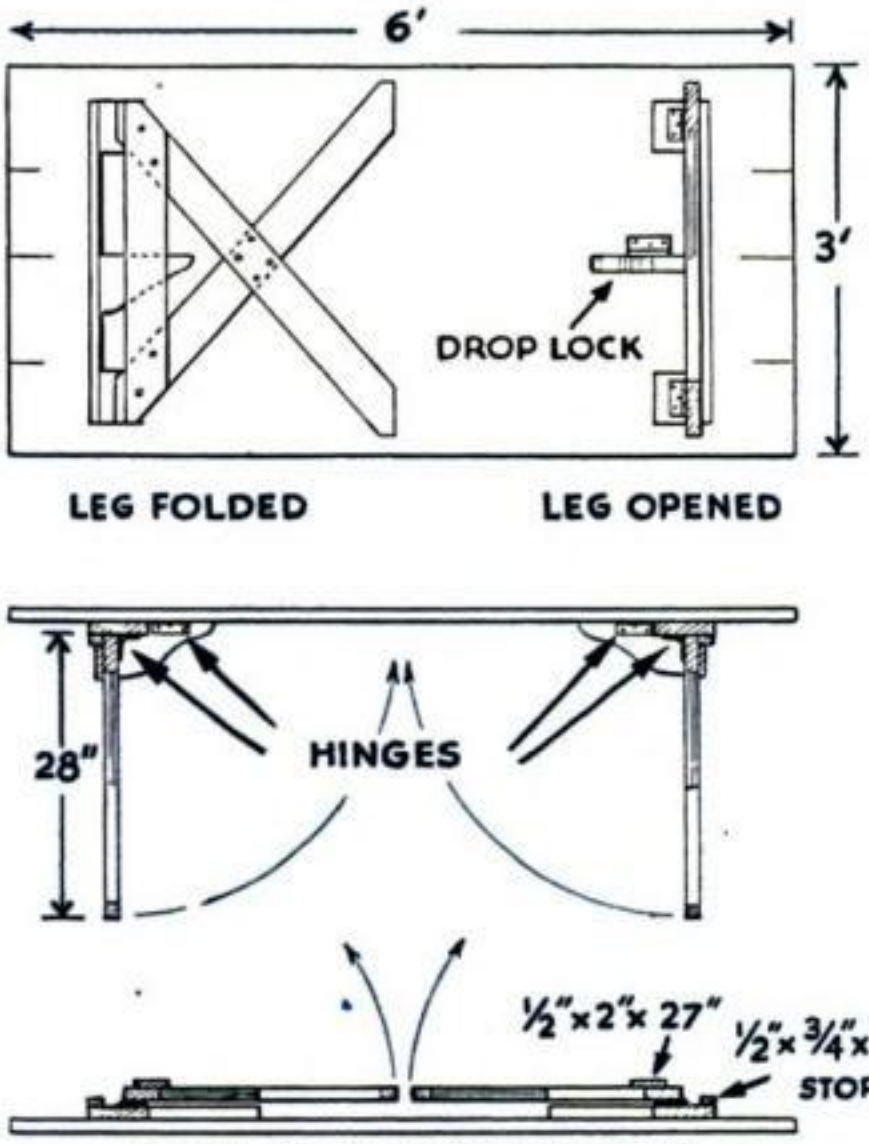
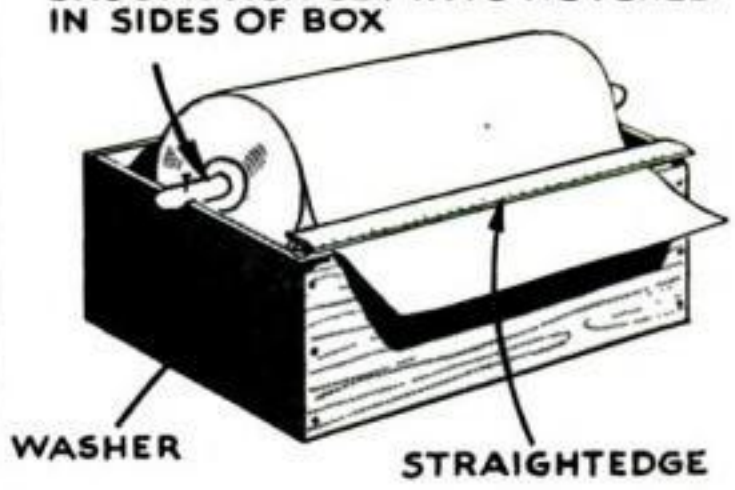


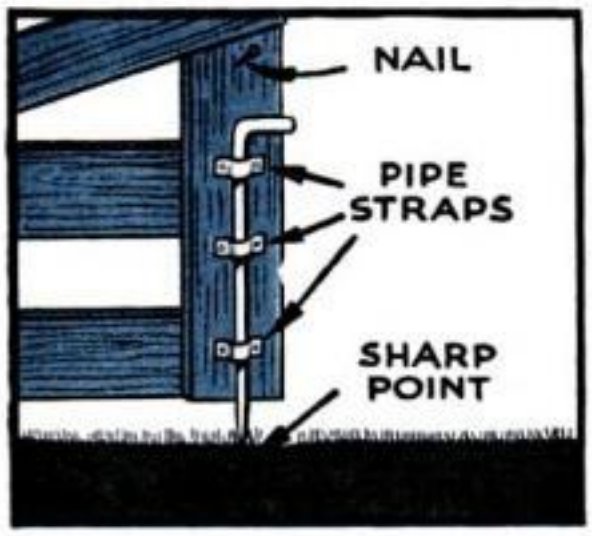
TABLE IN FOLDED POSITION

For out-of-door dining, here is a sawbuck table that can be folded up and stored out of the way when the meal is over. Stock ⅞" thick can be used for the top, cleats, and braces, but 1⅛" wood is best for the legs, which are hinged to blocks on the underside of the top so that they fold inward. A wood drop lock is also hinged to the top next to each set of legs, as shown, for holding the legs steady when the table is in use

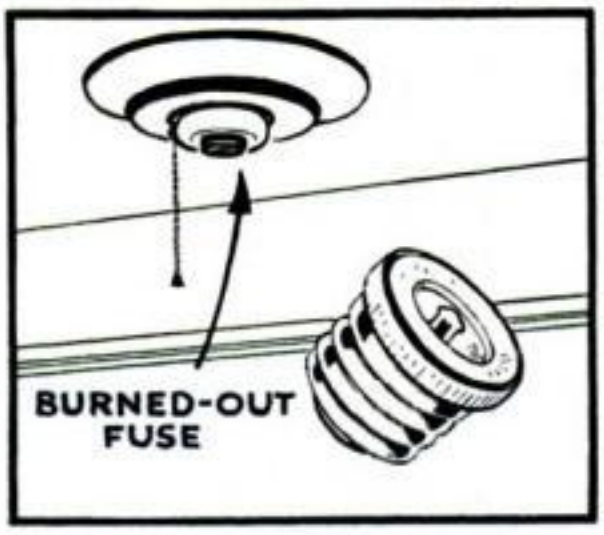




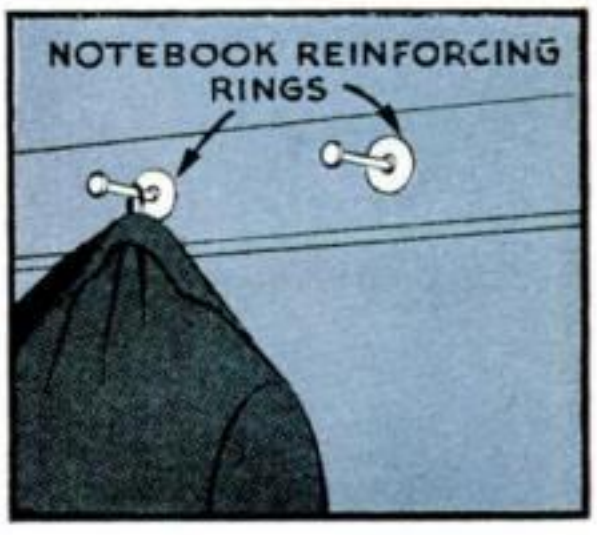
Rolled wrapping paper is handled easily if it is mounted on a broomstick in a wooden box. A wood or metal straightedge, raised on thin washers, serves as a tear-off bar



Pushed into the ground, this rod anchors a farm gate open. Pulled up, its bent end is held by a nail

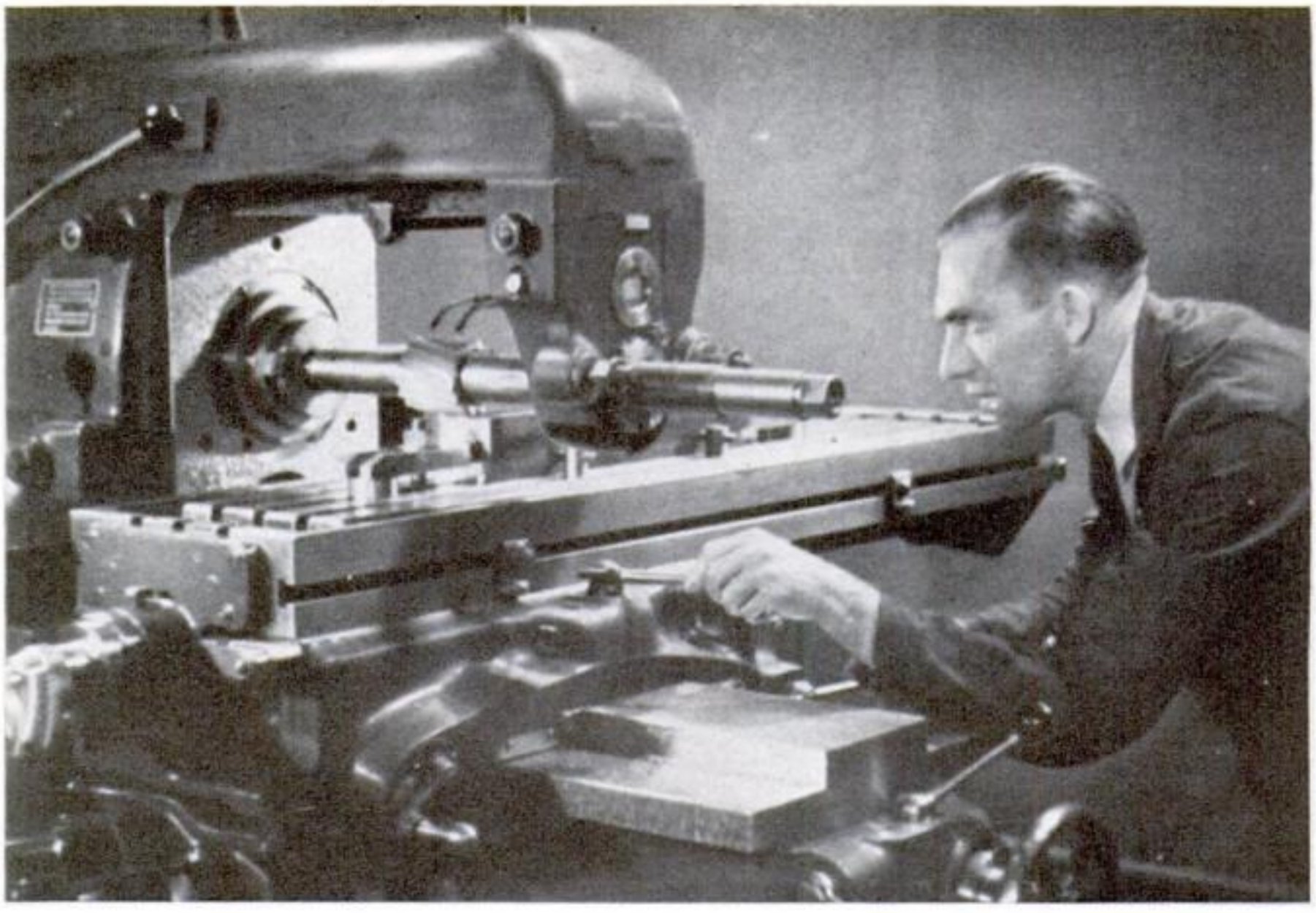


Old electric fuses screwed into light sockets keep the sockets clean when spray-painting is done



Loose-leaf reinforcing rings aid in locating nails used as garment hangers in dimly lighted places

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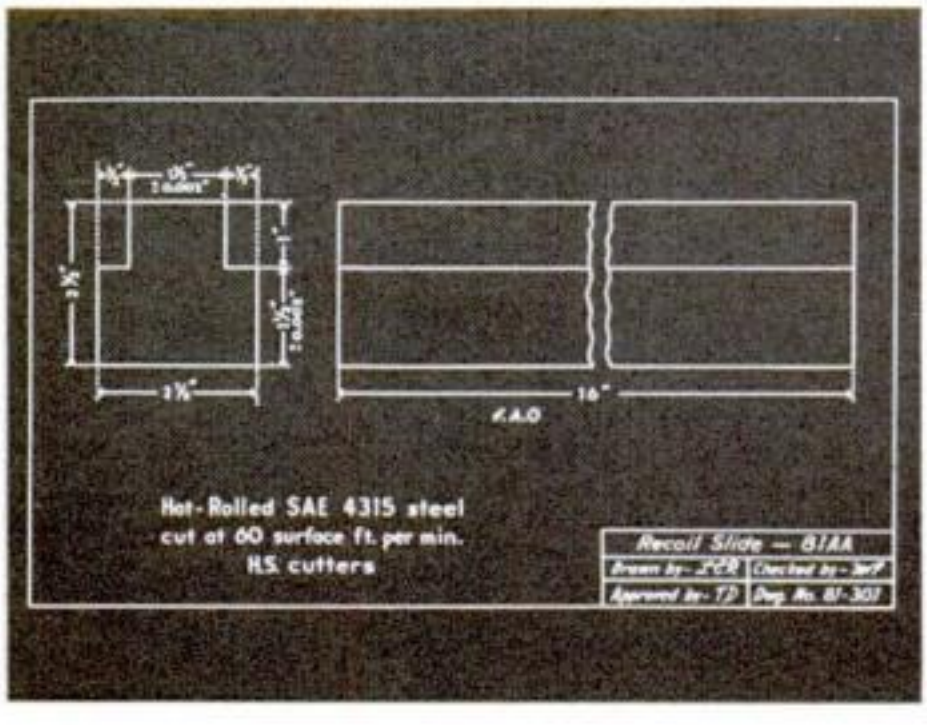


MILLING A T-SHAPED BAR

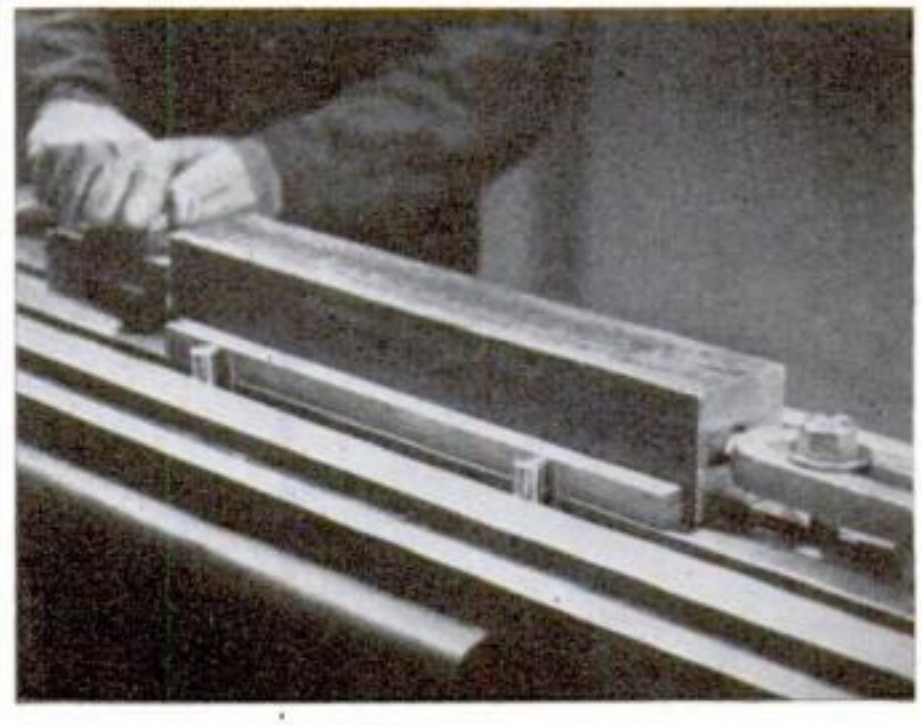
THIS is a job calling for three interesting operations on the versatile milling machine. First, the bar stock must be squared, taking slab cuts with a helical milling cutter; then the web and flanges are straddle-milled with two staggered-tooth cutters mounted on the arbor; and finally an end mill is used to cut the T-shaped bar to finished length. Careful checks with precision gauges are necessary after each short trial cut to assure accuracy.

A number of instructive steps in the job are shown on the following pages in pictures taken from one of the series of movies prepared by the U. S. Office of Education for use in training machine-tool operators for war plants. These films are distributed for the Government by Castle Films.

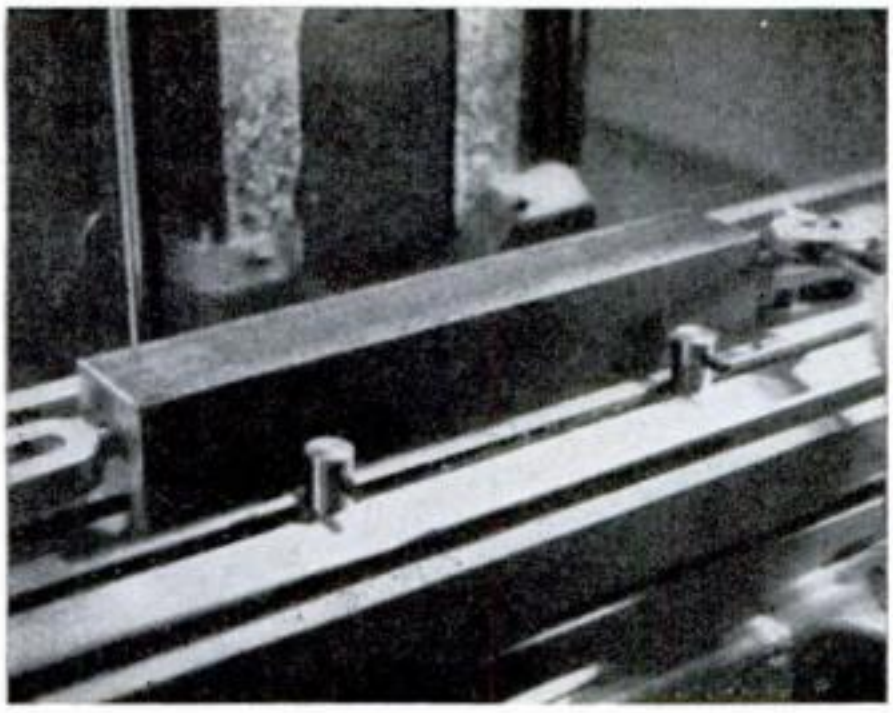
1 Here is a T-shaped bar to be milled from bar stock 3" square. The sides are to be milled flat and square to 2½"; then web and flanges are to be straddle-milled. Finished length is 16"



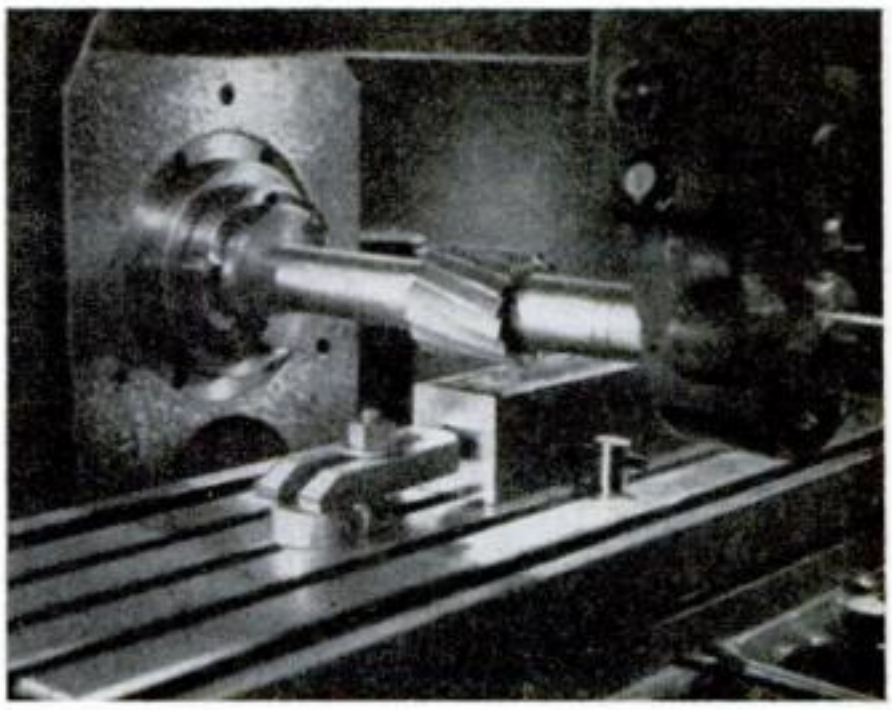
2 Cut an 18" length to allow room for end holes to take hold-down clamps and space for trial cuts. Align it with the cutter, uisng a parallel bar held against parallel pins set in a table slot



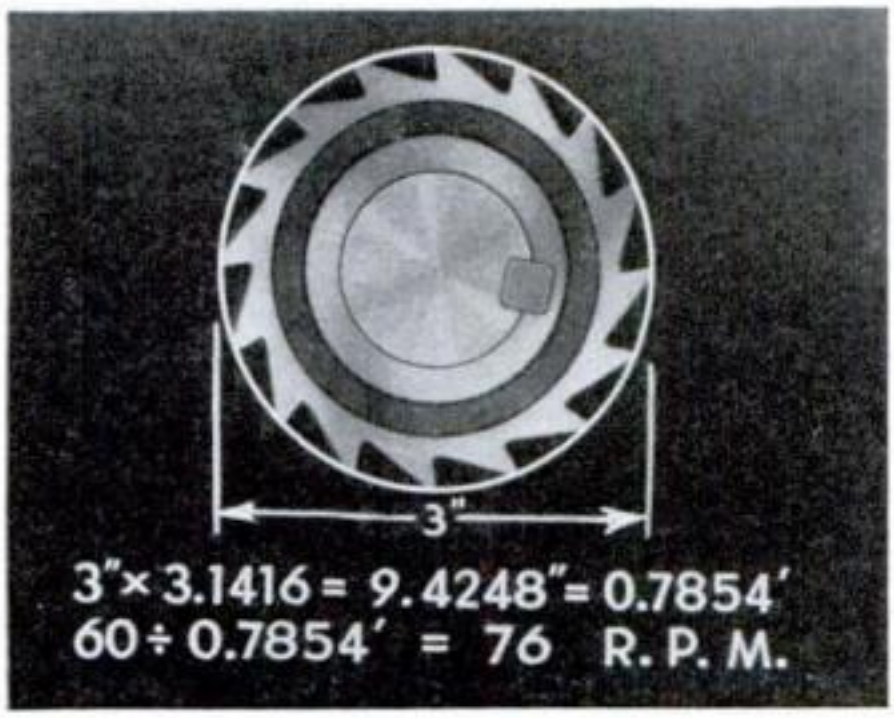
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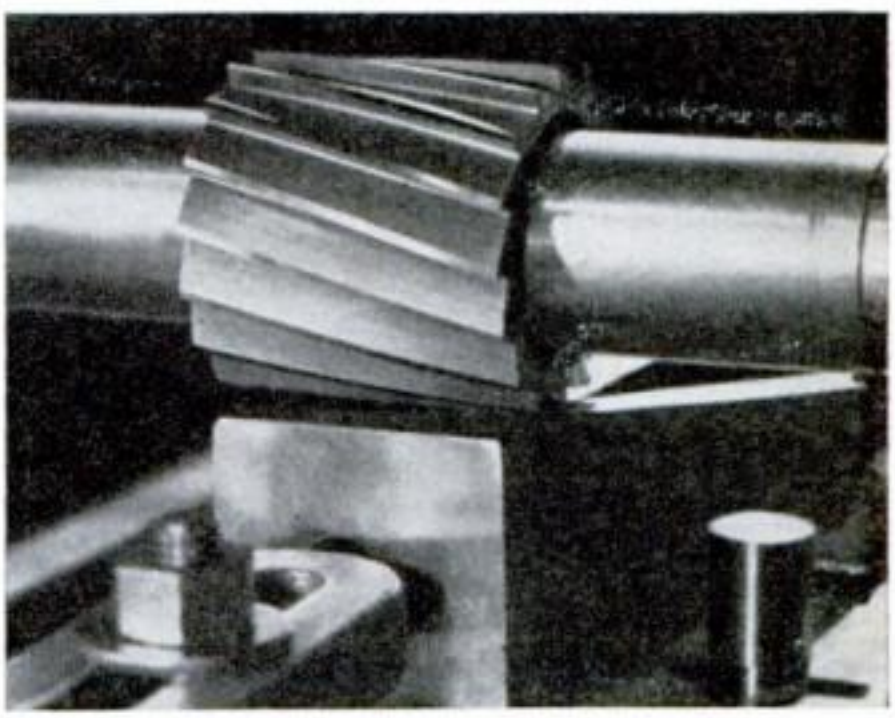
3 Push the bar stock against the parallel bar, tightening two small jackscrews also fitted into one of the table slots. Then the end clamps are tightened to hold the bar firmly to the table



4 All faces are to be slab-milled, one cut for each face, with a 3" diameter helical cutter. The cutter is mounted as close to the column as possible and on a short arbor to minimize spring



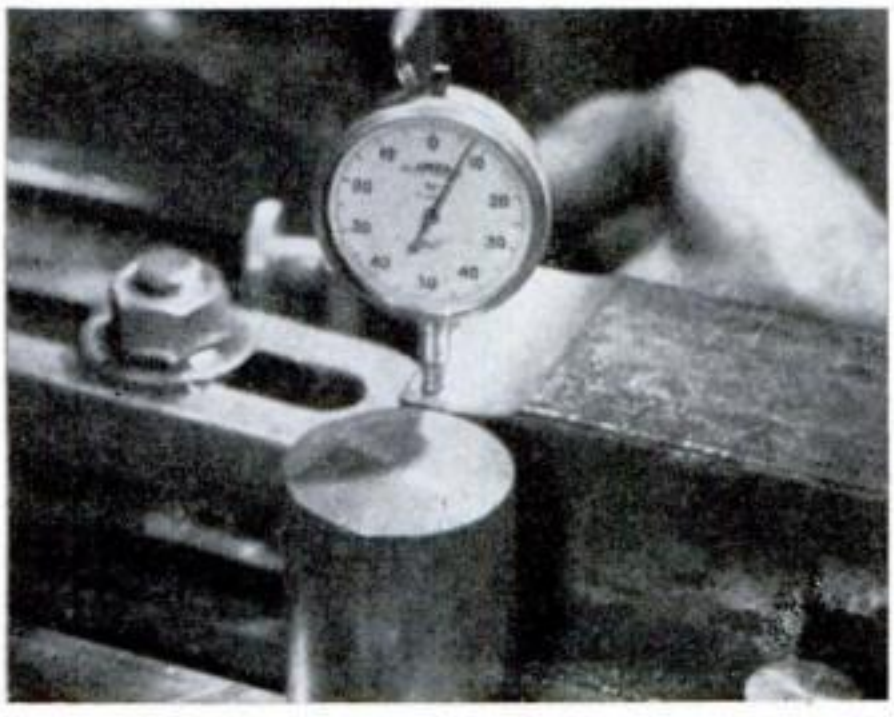
5 Since the specifications call for a peripheral speed of 60 surface feet per minute, set the cutter-speed dial at 74 r.p.m.; it is the nearest machine speed to the 76 r.p.m. calculated above

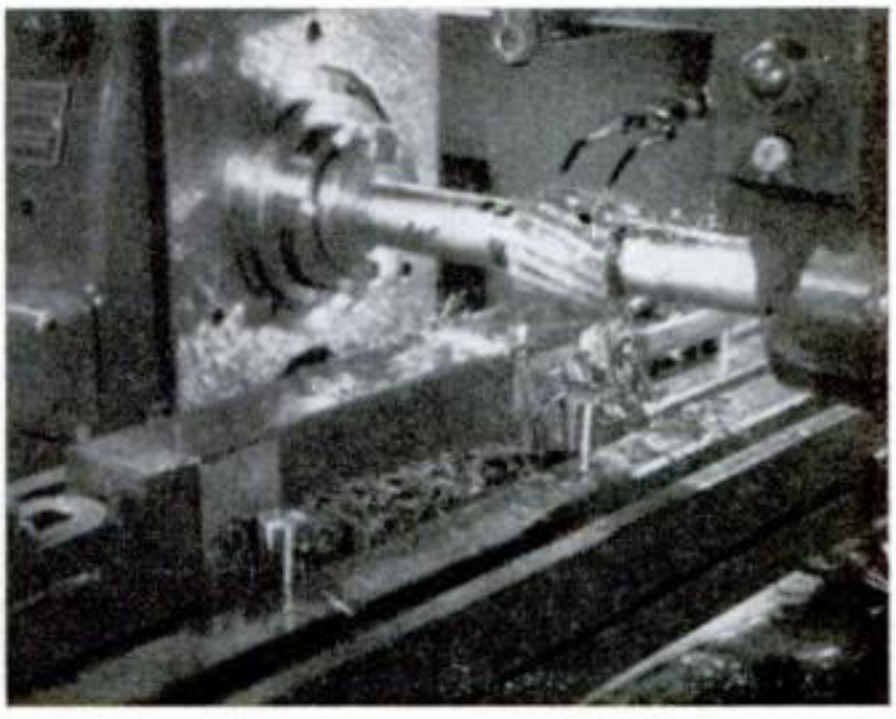


6 Set table feed for 6" per minute—a chip load of .005". In setting depth of cut, raise the work to a feeler gauge under the cutter; then run the work clear and raise it ¼" plus gauge height

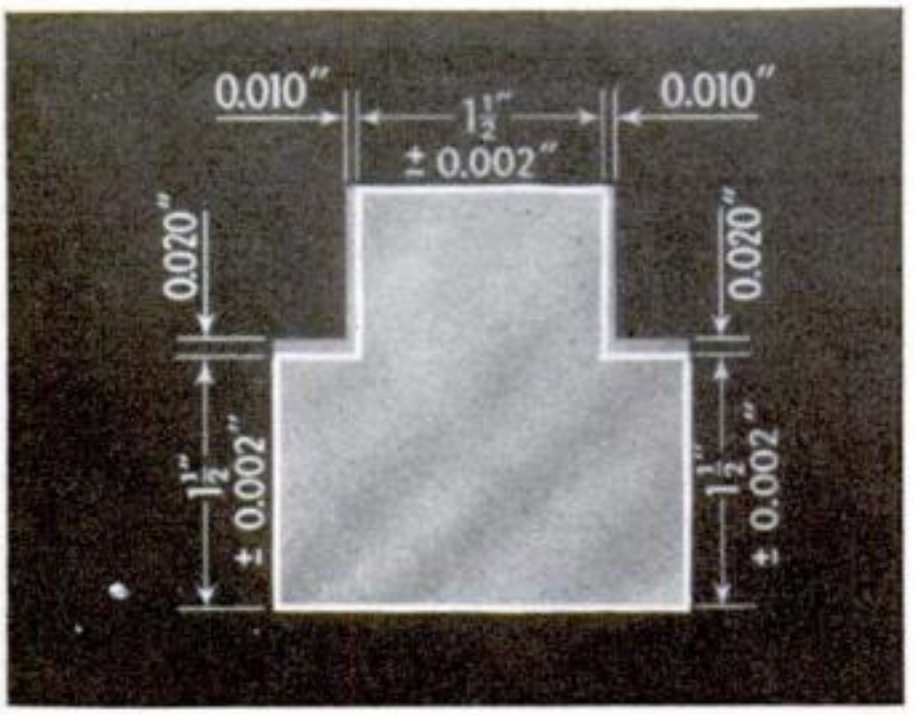
7 Mill the first side, flooding the cutter with coolant; then turn to the opposite face. Use a 2½" gauge block and a dial gauge placed on the table to check the depth after a short trial cut

8 Slab-mill the third and fourth sides the same way. Brass plates will prevent marring of a finished face by the jackscrews when the work is pressed against the parallel bar [CONTINUED]

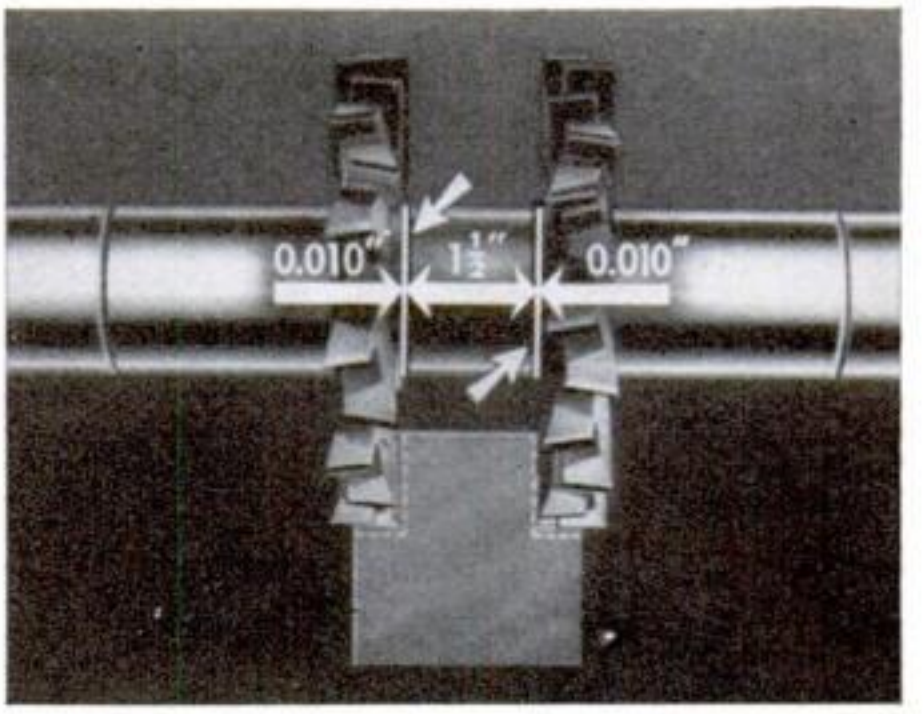




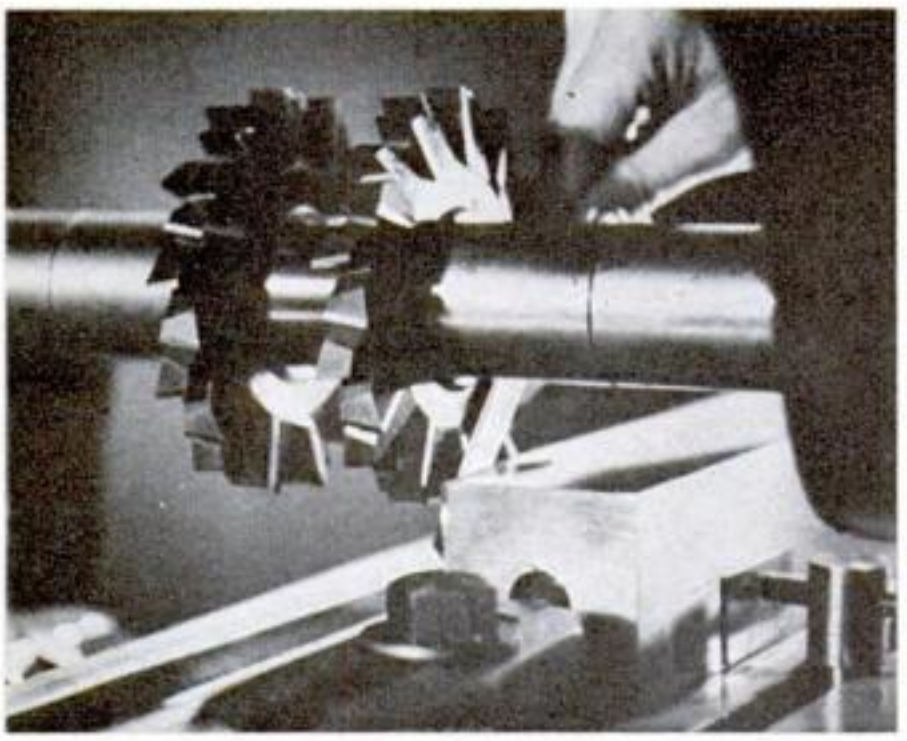
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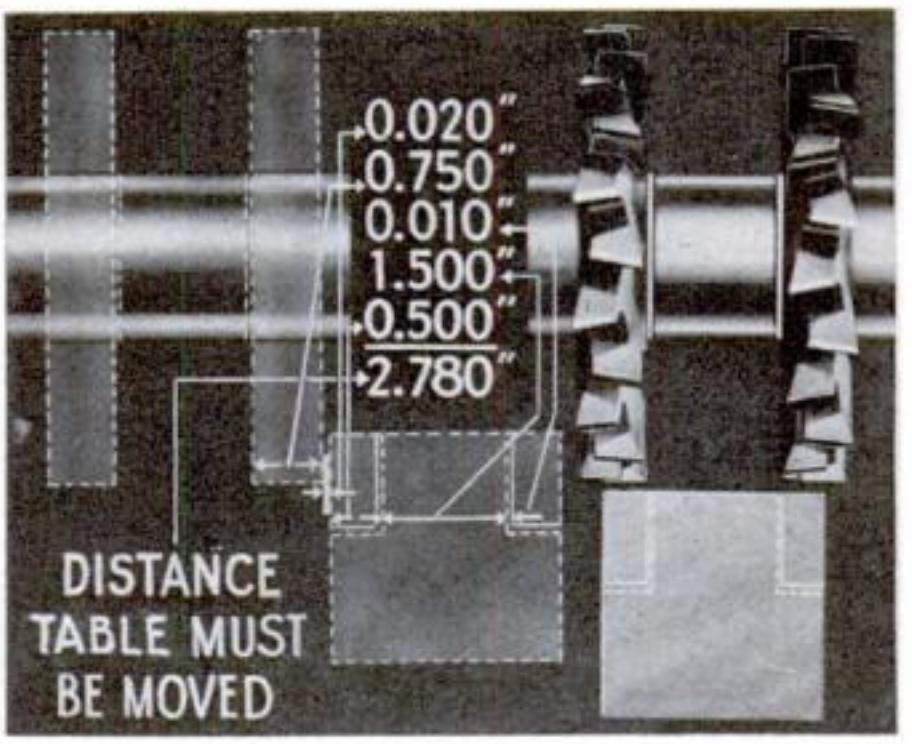
9 Check the height with the dial gauge and the width with a micrometer. The next step is to straddle-mill with one roughing cut, leaving .010" on each side of the web and .020" on the flanges



10 Mount the two cutters with a 1½" spacer and two .010" shims between them. The width of the shims is the amount to be left for finishing. Check both the spacer and shims with a micrometer

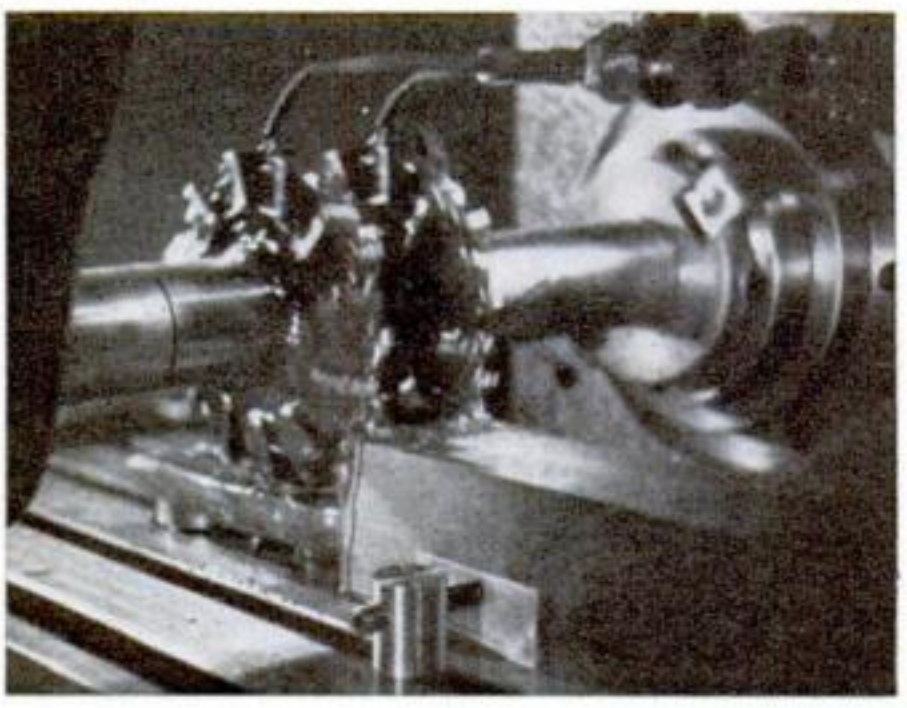


11 To center the cuts so that both the flanges will be the same, place the outside cutter against a feeler gauge held against the inside of the bar; then set the table cross feed at zero

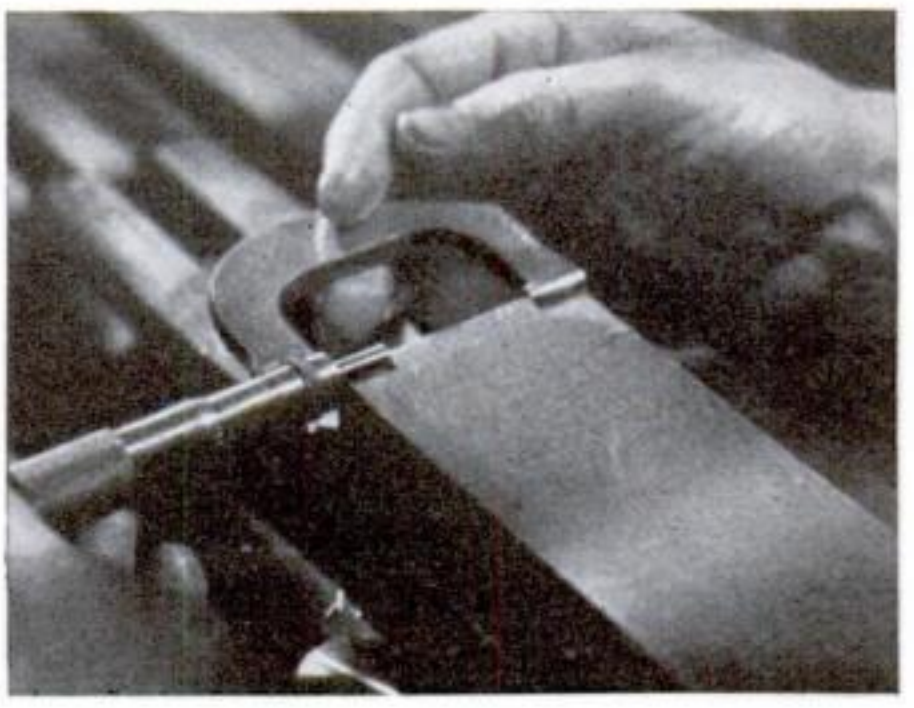


12 Lower the table, and then center the work by traversing the table 2.780"; this is the sum of the widths of the feeler, one cutter, one shim, the spacer collar, and one flange, as shown above

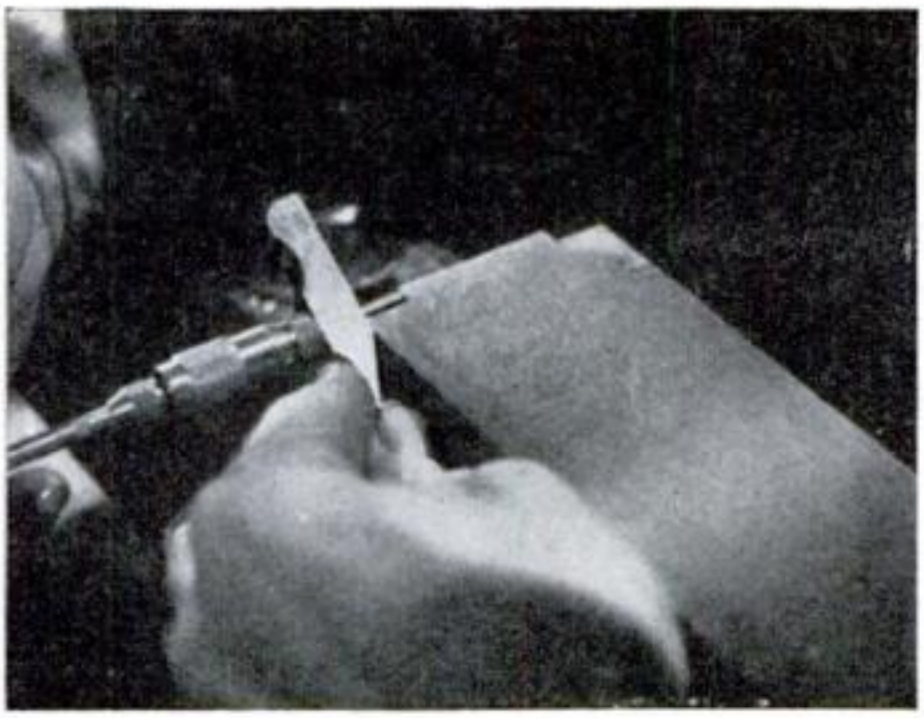
13 Set the table for a cut .080" deep and then make a trial cut, running the work into the cutters for a short distance ond using cutting oil to keep the cutters cool and to flush out chips



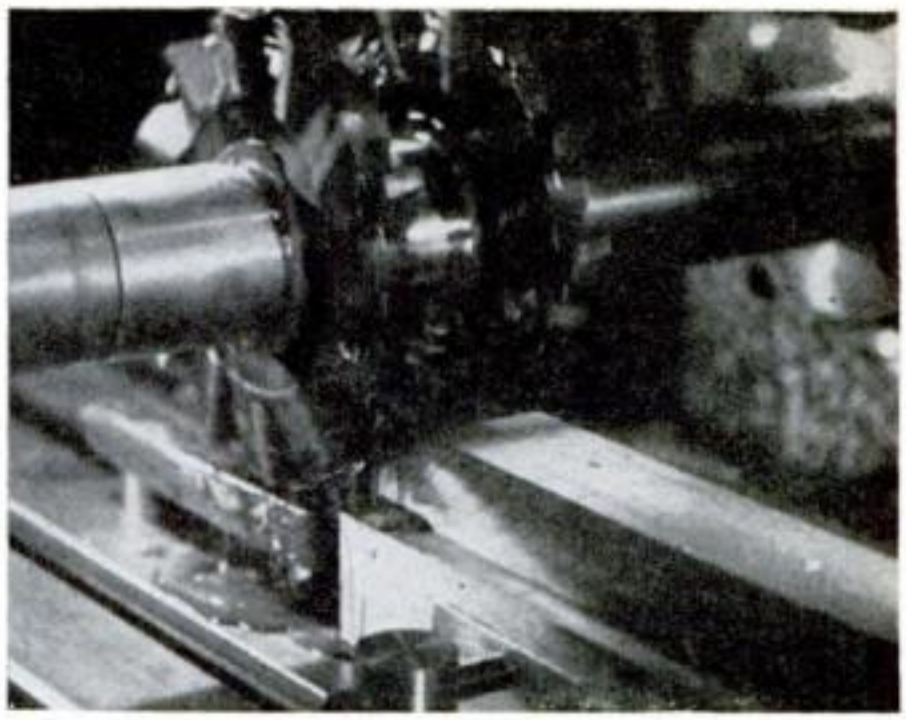
14 Check the width of the web with a micrometer to see that it is 1.520", which leaves .010" on each side for the finishing cut. The extra length of the bar leaves room for any needed correction



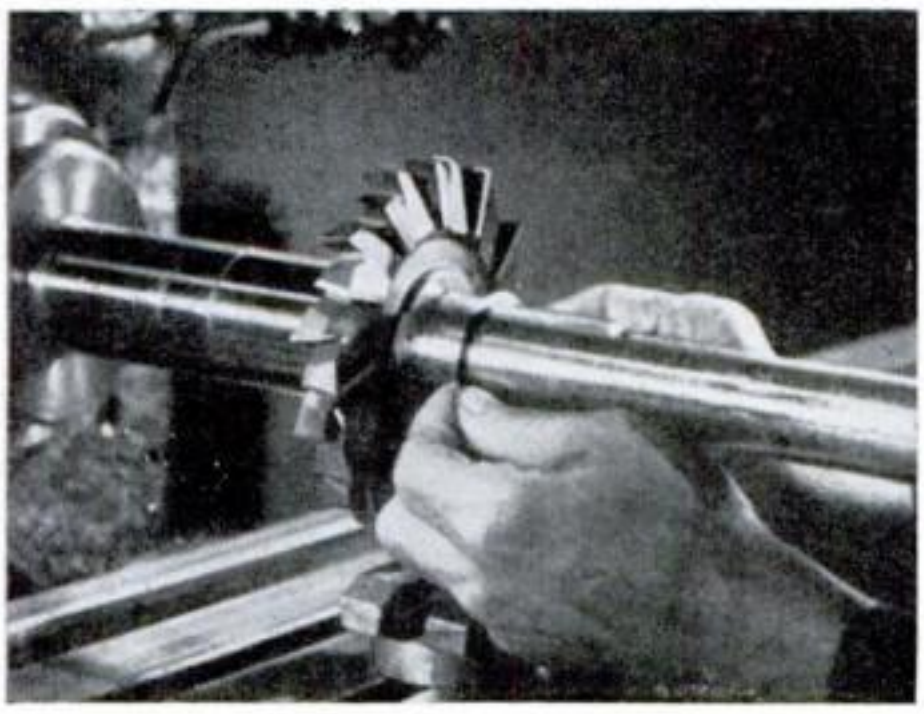
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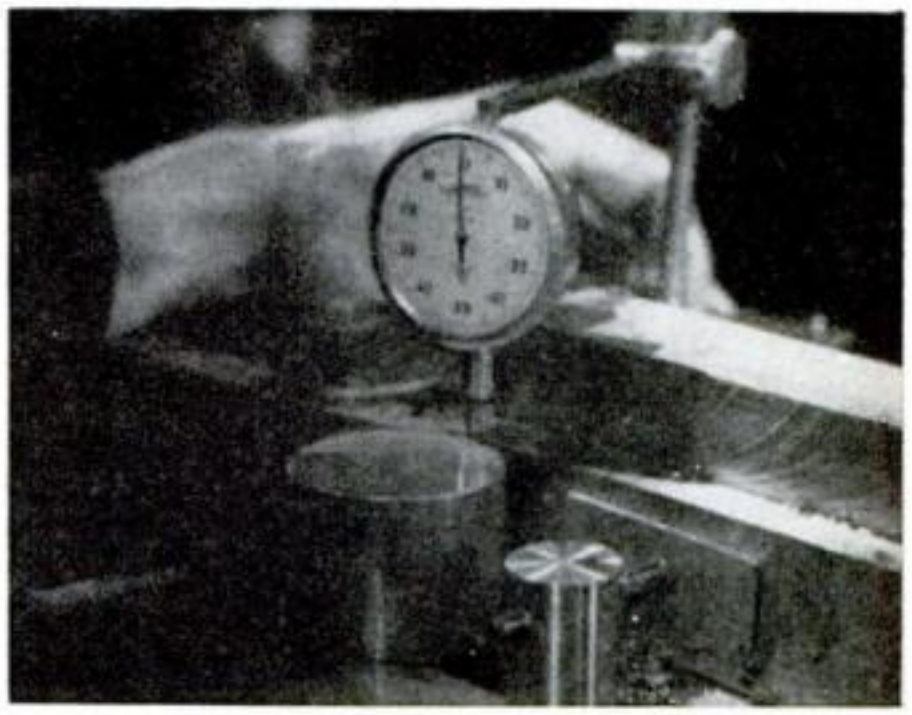
15 To be sure both flanges are the same and the web thus centered, check the distance from the side of the web to the side of the bar with a depth micrometer. A reading is taken on each side



16 Take the straddle cut at a feed of about 3" per minute—about half that of the slab cut. Note that the cutter teeth are staggered and set at alternate spiral angles for taking a deep cut



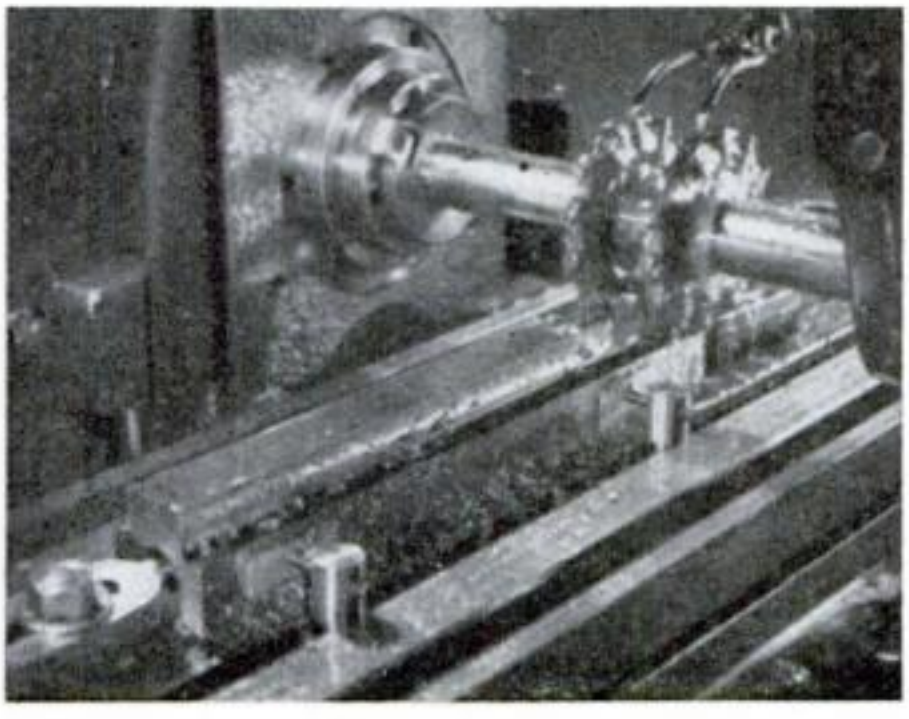
17 Using the same cutters, set them for a finish cut by removing the two .010" shims. Move the table over .010" to center the work, take a short trial cut, check, and raise the table .020"

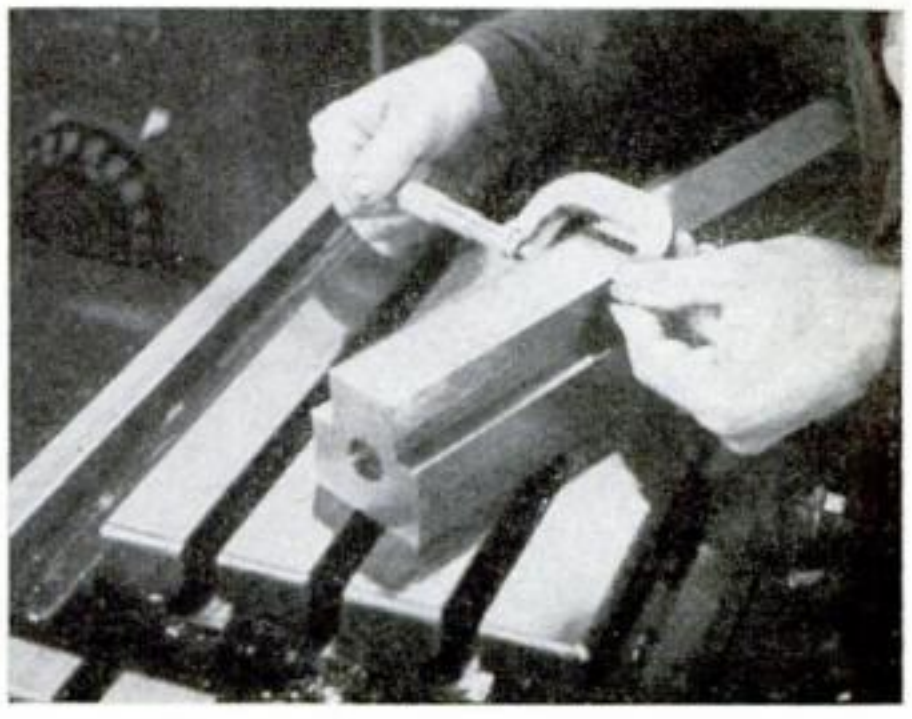


18 Another short trial cut is taken in the end waste, and the height of both the flanges is checked in this new cut with a dial gauge and a 1½" gauge block set on the milling-machine table

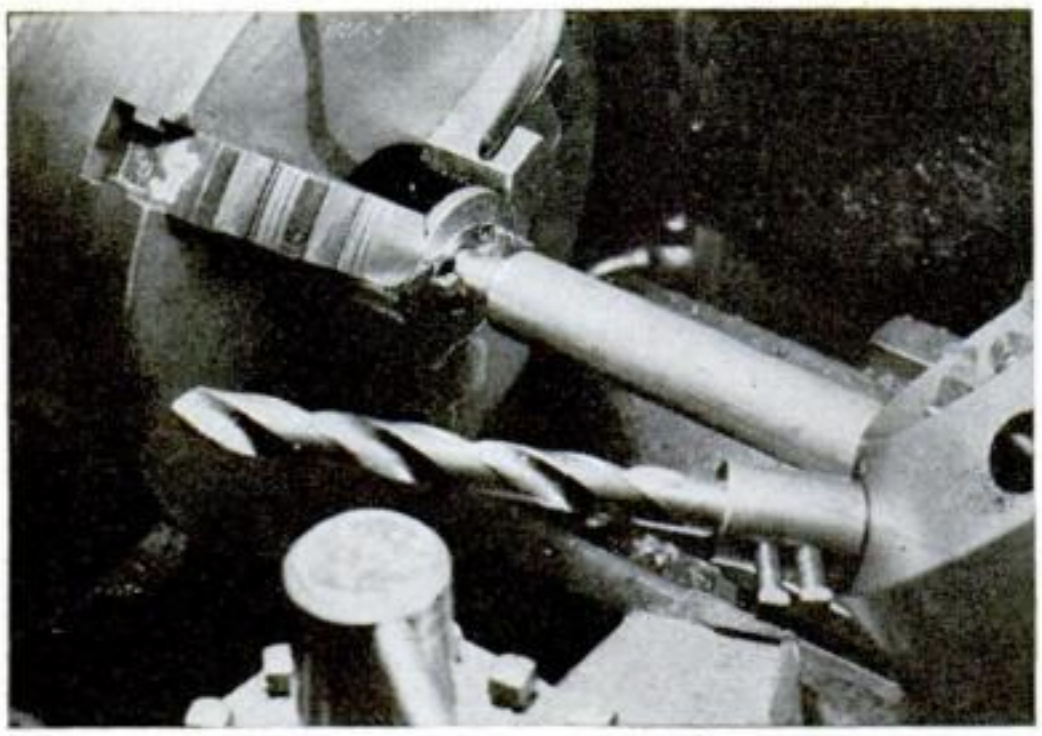
19 For a fine finish, increase the cutter speed and decrease the rate of table feed, but do not make the feed too slow because a tooth might slide without cutting. Use a flood of cutting oil

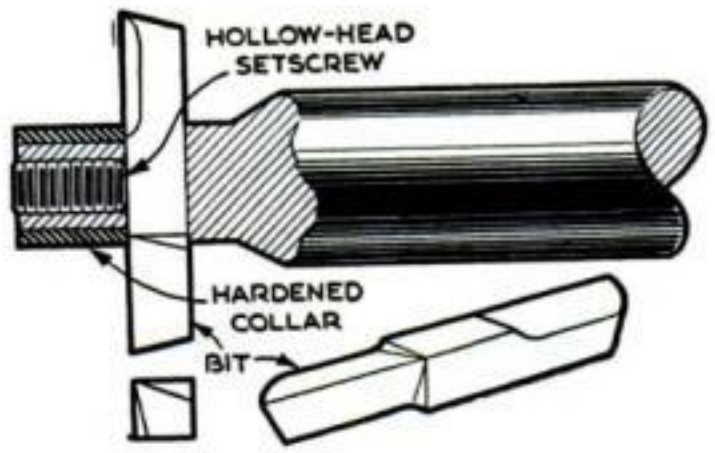
20 Check all dimensions against the blueprint; then set the bar in a vise on the table and take 1" from each end with an end milling cutter to bring it to 16", cutting off the clamp holes





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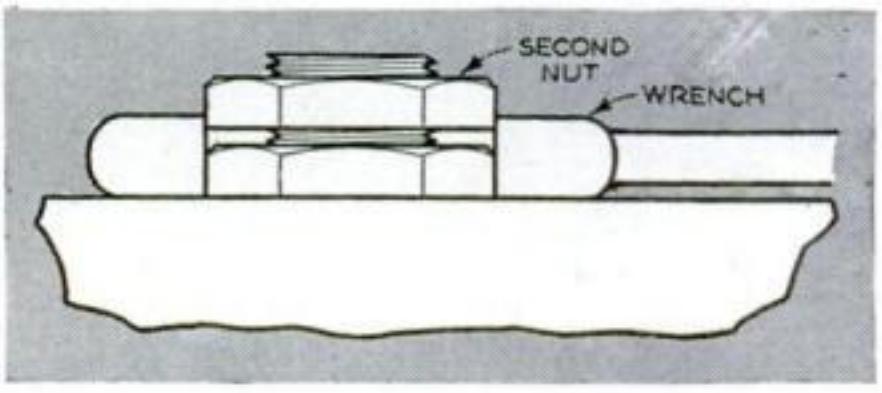


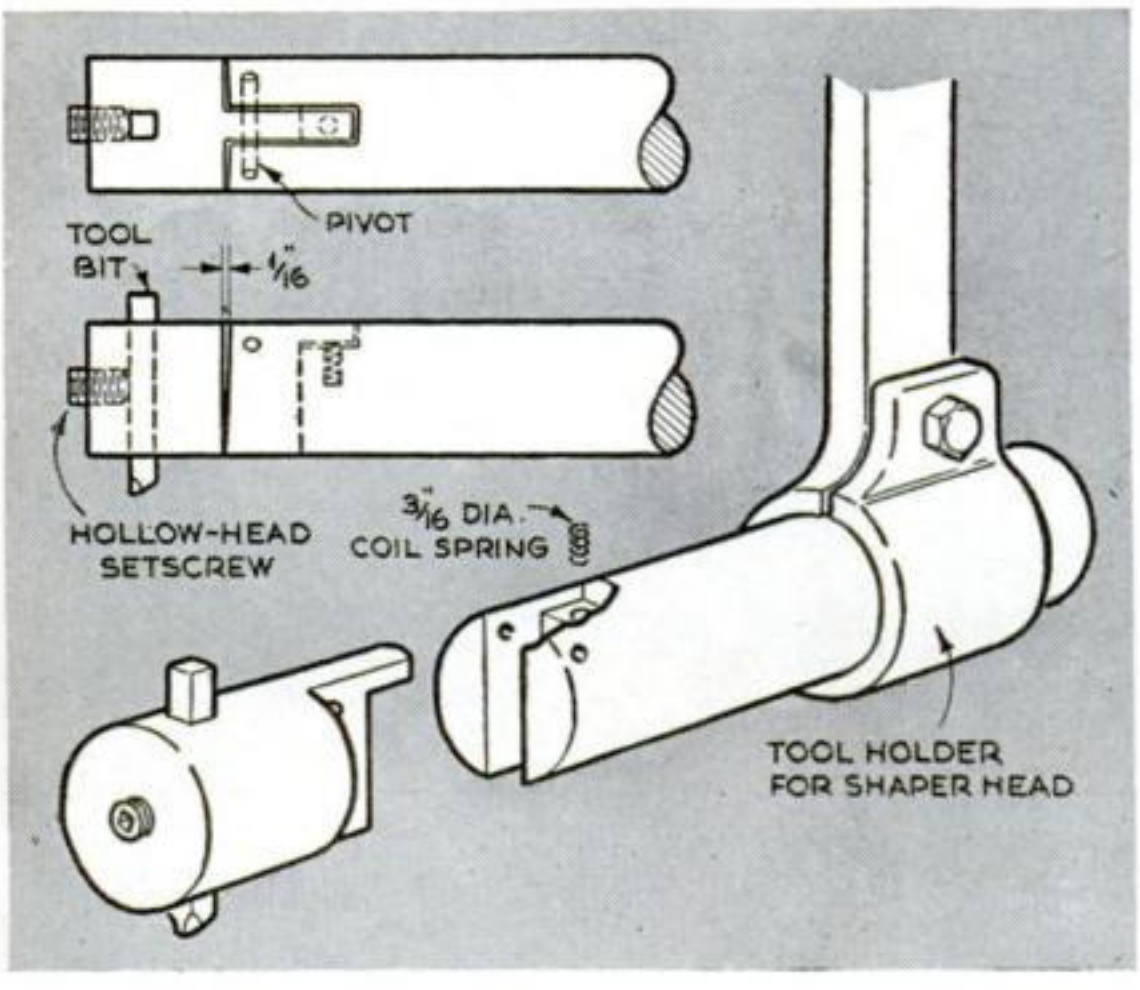
BORING LARGE HOLES is best done in the lathe with a boring bar. The one shown above was used successfully for boring 1½" holes in steel stock chucked in a lathe that had chattered with a twist drill larger than ½".

This bar, made mostly from scrap stock, was designed for use in the tailstock turret, but could be adapted to a cross-slide turret. Consisting of a ¾" cold-rolled bar turned down to ½" diameter at the boring end, it will hold either a single or a double-bladed bit. The first ½" of the boring end serves as a pilot in a predrilled ½" hole in the work and, to save wear, can be turned down slightly and fitted with a fairly thin hardened collar, as shown in the drawing. Well-lubricated bronze may serve on some jobs. Either round or square bits can be inserted in the ¼" square tool hole.

The boring bar, plus an assortment of bits, will make holes up to the capacity of the lathe. Use it to enlarge the pilot hole to within 1/32" of the finished size; then true the sides with a boring tool mounted on the cross slide.—W. E. B.

USING A SECOND NUT over a thin machine nut, such as a lock nut, will present a greater surface for gripping and keep the wrench from slipping off. Leave a space between the two nuts so there will be no chance that the top nut will keep the other from being seated securely. The top nut is, of course, removed after the tightening has been completed.—THOMAS TRAIL.



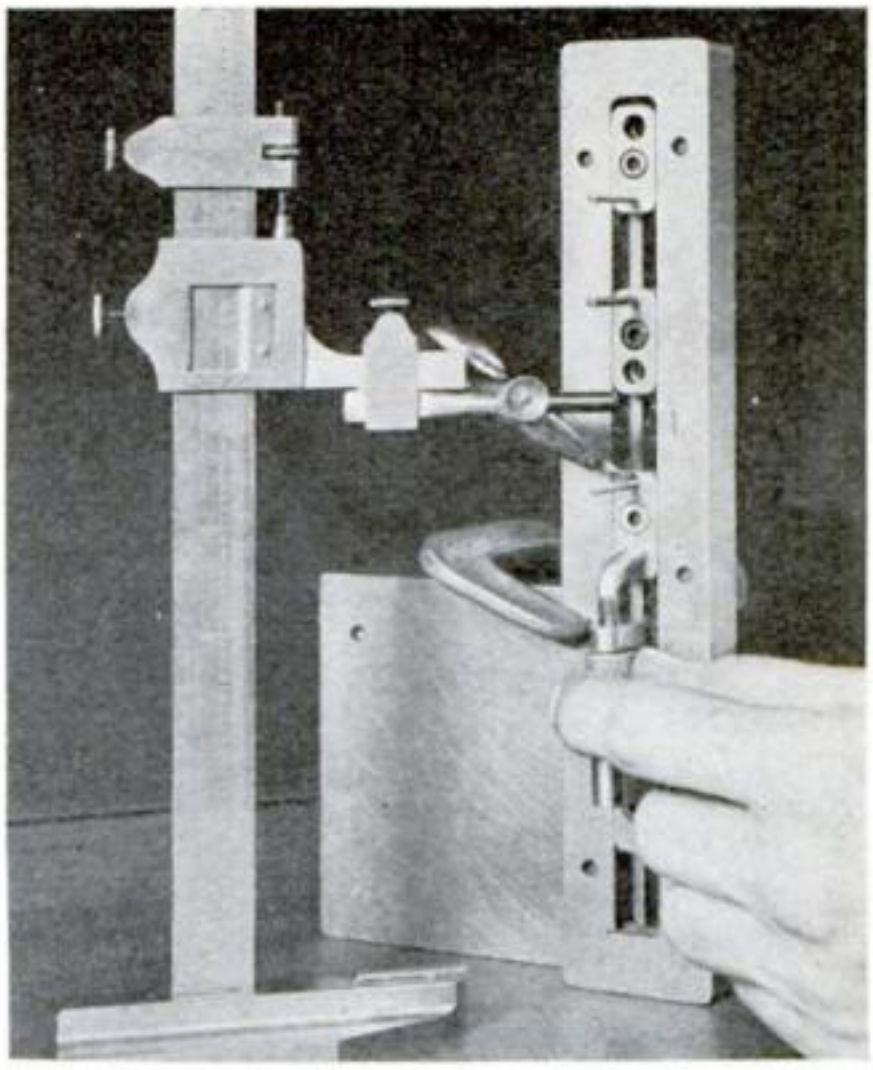


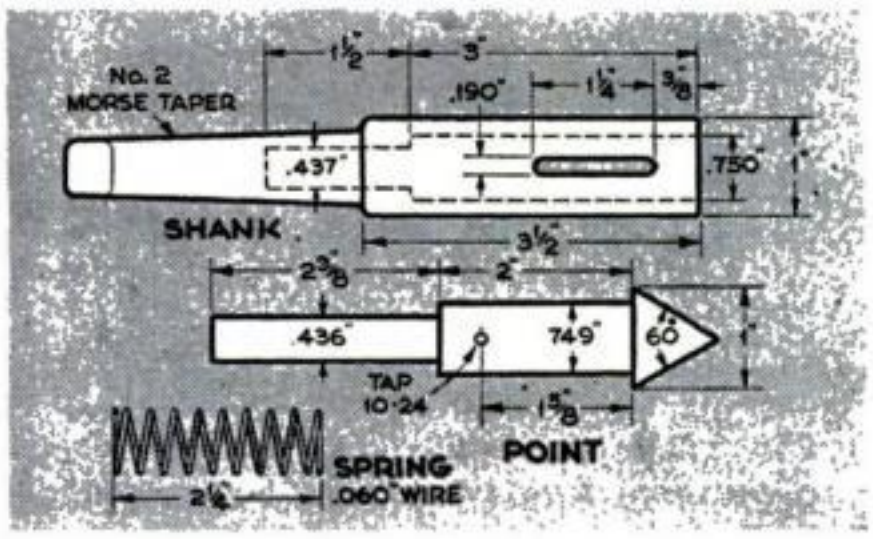
RETURN-STROKE LIFT just behind the bit is provided by this holder designed to keep the cutting edge of a shaper tool from dragging on the work. The main part of the tool holder is cylindrical and consists of two pieces fitted together with a stepped joint in which there is a 1/16" gap to allow a hinged movement on the return stroke. A small coil spring in this gap puts a slight pressure on the hinged part to keep the tool pushed down fully on the outward cutting stroke. The assembly is held in a bracket, which in turn is inserted in the customary way in the tool post of the shaper. All parts are shown at left.—H. D. C.

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DRILLING A SERIES OF HOLES where fine tolerances must be maintained between two holes, or where three must be drilled in a straight line, is simplified by the use of the adjustable drill jig shown at the right. Distances are established on the bar, which is then clamped to the work, and drilling is done through the guide holes. Use of the bar eliminates drilling to a scribed line, a procedure that is often subject to multiple error.

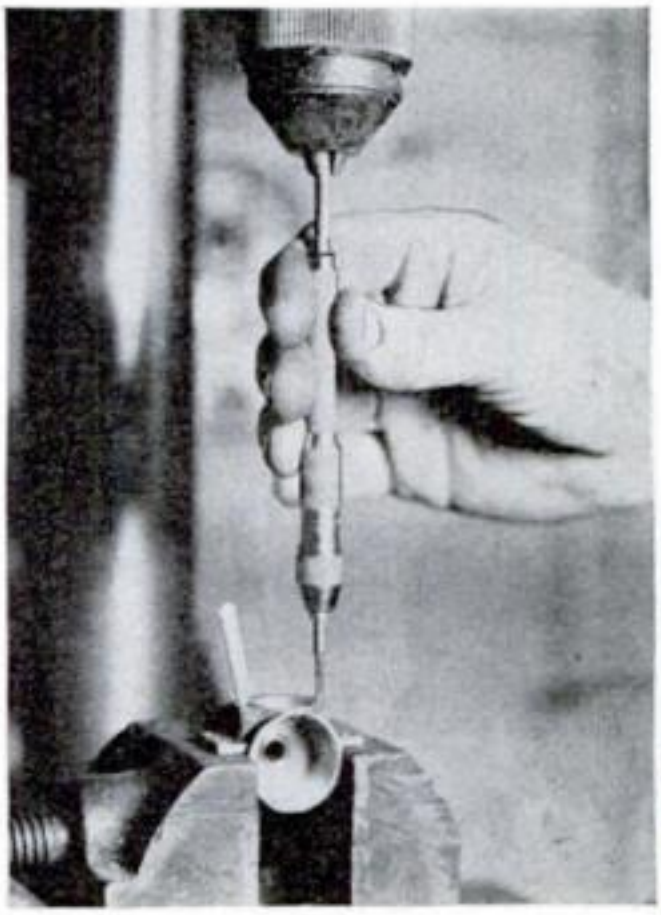
Drill blocks, in which the guide holes are located, slide in a grooved slot in a metal frame and can be locked in position anywhere within the frame. In the photo, the bar is shown clamped temporarily to a milled block and so held vertically while distances between bit shanks in the guide holes are set with the aid of a vernier height gauge, but calipers could be used as well. Final adjustment is made with a micrometer. Accuracy to .001" is said to be possible. The bar was invented by Arthur Anderson, a mechanic at the Northrop Aircraft, Inc., plant at Hawthorne, Calif.

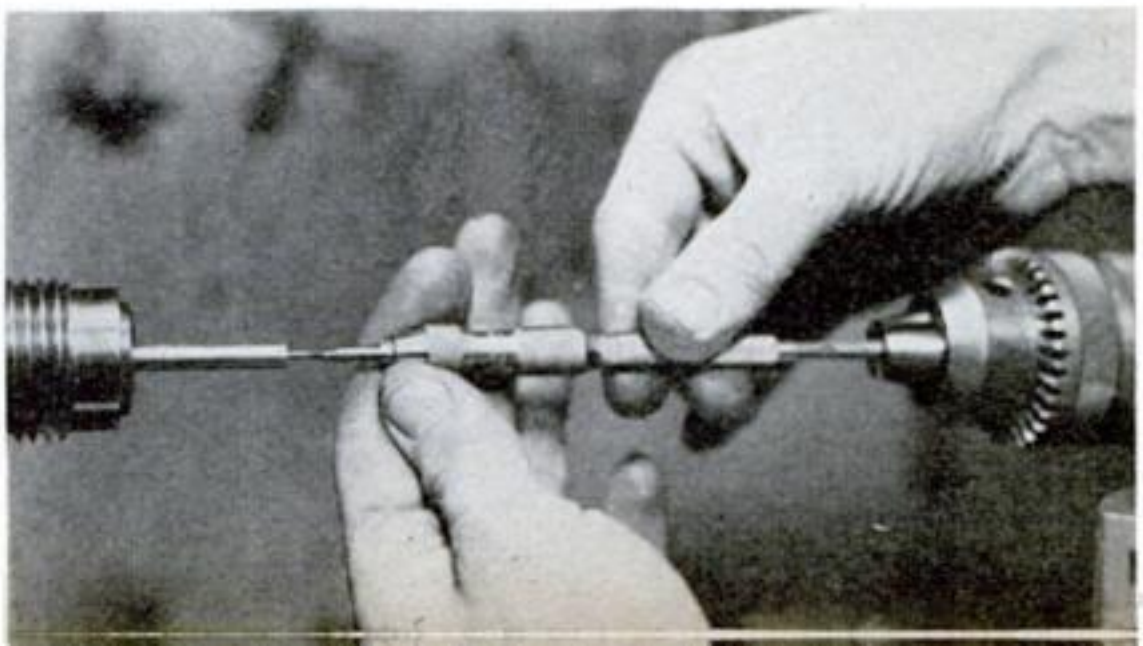




THIS FOLLOWING CENTER for a reamer, tap, or similar tool is equipped with a spring to provide flexible pressure when mounted in the lathe tailstock or in the drill press. Turn the shank first to a No. 2 Morse taper; then slip the shank in the lathe spindle, support the end in a steady rest, and drill and bore. Turn the center, leaving a stub on the end and .015" to .020" on the face of the point for final grinding after hardening. Tap for a setscrew, however, before hardening.—ROBERT L. HOTTMAN.

BREAKAGE OF SMALL TAPS can be avoided by mounting them in a hollow-shank pin vise of the type used by model makers and jewelers, and then setting the work up in the lathe or clamping it on the drill-press table. A rod that is a free-turning fit in the hollow shank is fixed in the chuck or tailstock spindle. This holds the tap in perfect alignment, preventing that side motion that often results in breakage. The pin vise is turned with the fingers only, as shown. The motor is, of course, not turned on.—E. R. LOSCH.





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Houses Are Photogenic

PRACTICAL POINTERS ON A NEGLECTED SUBJECT FOR PHOTOGRAPHS THAT HAVE A TRUE PICTORIAL QUALITY AND YET NEED NO SPECIAL EQUIPMENT

By Florence C. O'Connor

Photographs by the Author

FEW byways of photography are more satisfying than taking pictures of houses. The full possibilities of houses as camera subjects are often overlooked by the unimaginative amateur—who may instead bewail the "lack of good picture material in my neighborhood." Actually, whether you live in city, town, or country, there will be buildings nearby that will offer a real challenge to your camera sense and technique.

It's true that there are plenty of rules and technical commands in camera texts about architectural photography—too many, perhaps. Very likely these rules have frightened many an amateur away from photographing houses, even though he is the same camera fan who without a quiver of a plate-holder attempts portraits of his mother-in-law. What is often not realized is the fact that taking pictures of houses is a vastly different thing from architectural photography.

In the latter case, precise verticals and needle-sharp detail are all-important. But pictures of houses should offer something more than a static, correct appearance. If a house is to take up the greater portion of your picture space, try treating it as you would a portrait. What you want to show is the character of the sitter—the house—and its effect on you as a discriminating photographer. If you wish to treat the house as you would a person in a realistic character study, then the homely or intimate features in its everyday surroundings are important, and they must be welded into the story you want your picture to tell.

No architectural photographer would be caught without his tripod, but if you do not happen to have one, don't let it bother you.

[*Turn the page.*]



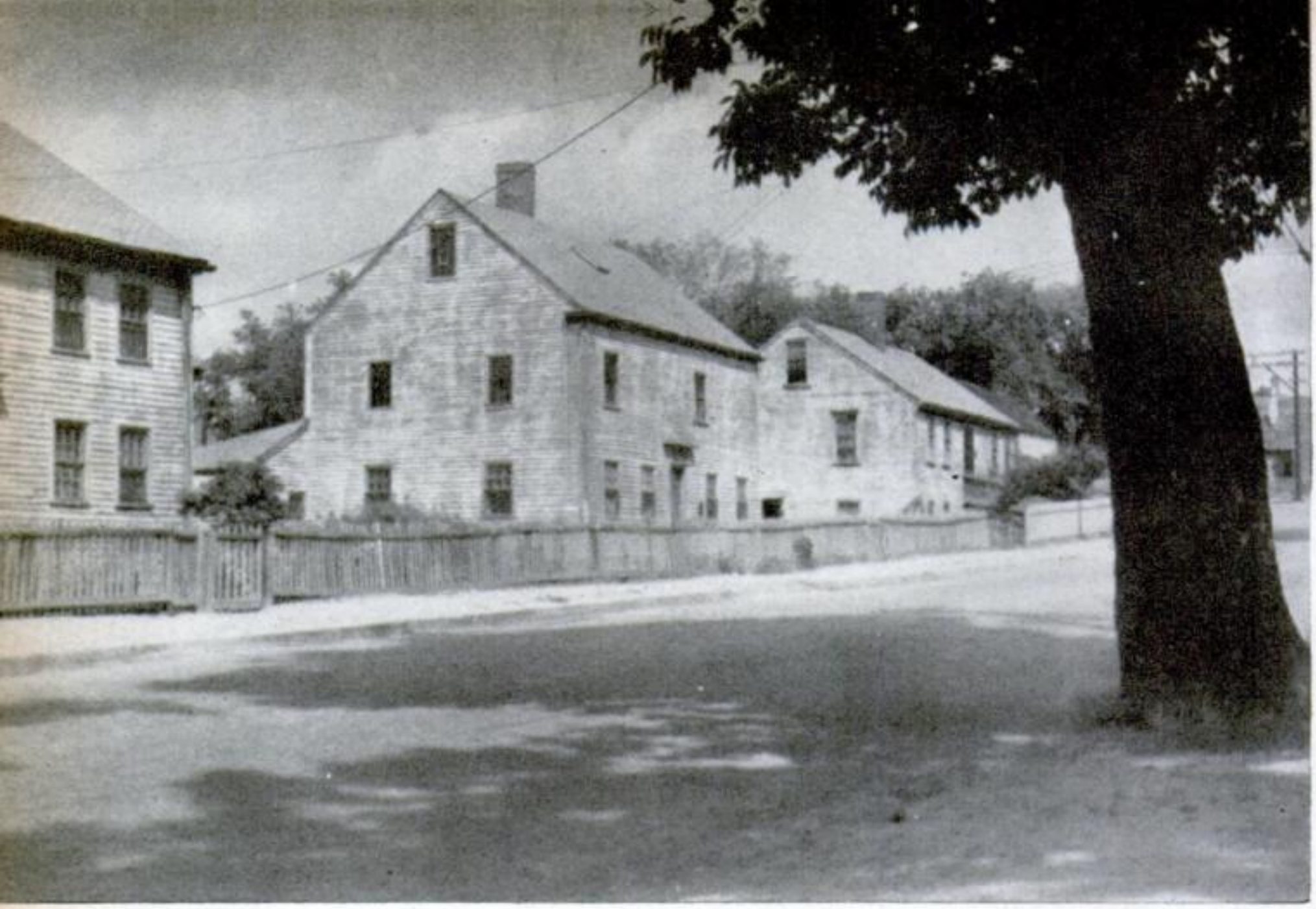
Magnolia Tree

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In the Shade of the Elm

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Village Street

Since effect rather than detail is what counts, perfect perpendiculars are not so important, though a tripod will be a help in giving you a chance to compose the picture more carefully. Don't worry either if your camera does not have a rising front. No one but the strict architectural photographer is going to mind much if the walls have a slight Tower-of-Pisa quality. If the verticals turn out to be badly tilted, you can compensate for this by tipping the easel when enlarging.

Before you click the shutter, it's a good plan to study your subjects at different hours of the day and seasons of the year in order to see what kind of lighting comes closest to giving the right impression. Houses have a way of changing their appearance according to the time of day and the season; a building that seems warm and gracious on a spring morning may well look gaunt and bleak in a winter twilight.

More of this selective judgment can be exercised when you make up the final print. Sometimes by changing light values or by toning you will be able to intensify or soften the mood of a scene. The use of a texture screen is worth considering. Do not forget also that cropping is useful in concentrating attention on the main theme.

City homes and structures may prove more difficult subjects to photograph than some isolated building. In photographs taken in cities, the most important thing to avoid is clutter and confusion, with a resulting "busy" print. Your job should be to concentrate on one idea and one idea alone. Pedestrians may sometimes pose a problem, but they are easily avoided if you choose some quiet time, perhaps early on a Sunday or holiday morning. Don't, however, overlook the possibility that their presence may contribute something to the picture. Should this be so, it's preferable to snap them when they walk away from the camera; they are less apt then to have a self-conscious look, and their backs will give them an anonymity which helps prevent them from overshadowing the main theme, the house. Moreover, the fact that they are walking away from your lens will make it easier to keep them in focus, since the depth of focus increases with distance from the lens.

Parked automobiles will occasionally present a difficulty in photographs of city houses. Experiment first to see if you can manage a view from the sidewalk; and if you have to include a car, try to show only part of one and that in the shade.

Cities abound in close-up material for a pattern picture of houses. Lending itself to a scene of this sort is "Magnolia Tree."

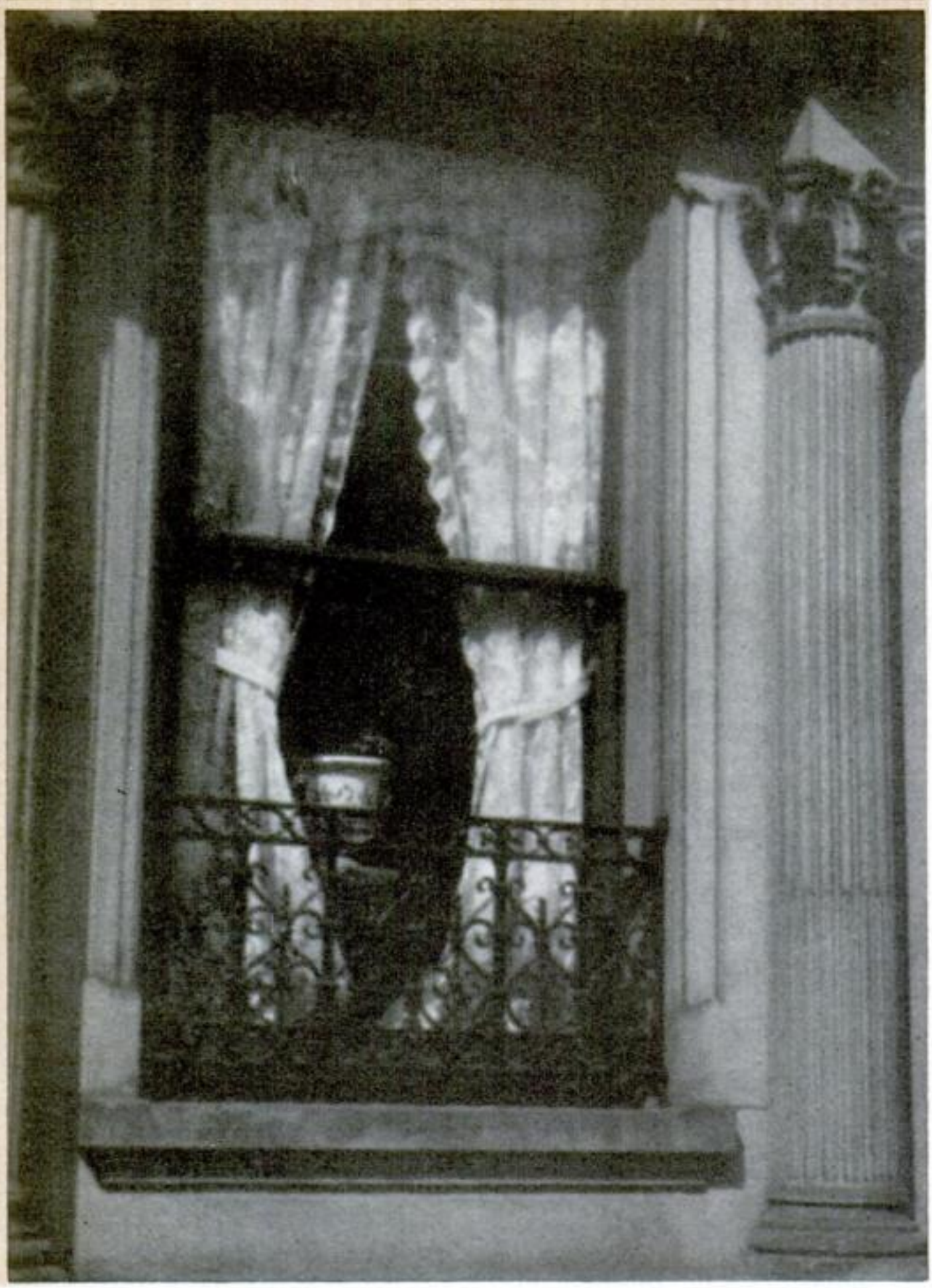
"Marlborough Street," at the right, suggests ways in which the author handles problems offered by pedestrians and the necessity of a hand-held shot

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The gnarled branches contrast strongly with the smooth roundness of the balustrade posts. The bay window and steps are features of a typical city dwelling. Sometimes a picture of a whole street will tell your story better than a single house. "Marlborough Street" was taken in early autumn, as the leaves were thinning and sunlight filtered on the repetitive bay windows. The idea here was to show the peace, conservatism, and quiet of an old Boston street, each house exactly like its neighbor, yet each stiff with its own dignity.

This was a hand-held shot, and since the resulting negative was slightly fuzzy, I made a virtue of necessity and printed the picture through a texture screen. The lack of detail helps make it a picture of an era rather than a picture of certain houses on a certain street. Notice, too, that a car parked at the left is seen only in shadow—making it a negligible detail. [*Turn the page.*]





Victorian Window

An excellent effect can sometimes be gained by concentrating on a single feature of a house. Doorways lend themselves well to this, while pictures of windows are equally effective, though they have had less vogue. "Victorian Window" suggests that inside this residence there lives a family of placid, dignified people. It wasn't necessary to show the entire house to convey this idea. A view of one window is quite enough.

Of all pictures having houses as their subjects, those taken in the suburbs are perhaps the hardest to endow with a true pictorial quality. Suburban homes are apt to be colorless because they are too new or too conventional. However, most suburban towns have a few pictorial streets or houses that are worth photographing. If these are not to be found, certain details in the surroundings can be pointed up to enliven an otherwise dull picture. For example, leaves burning in the gutter or high drifts of snow along the street are two features that might dress up the scene. Be careful to avoid or minimize such distractions as power wires or telephone lines. If there is no acceptable angle that does not have wires running across some portion of it, use a filter to reduce contrast between the sky and wires.

"Village Street" was taken in the old part of a mill town. For more than 100 years, the houses shown have been tenanted by factory workers. What caught my eye was the dilapidated fence and gray, weatherbeaten shingles, features that seem to symbolize the community and its history. The street was included to give the picture a long look—as though these houses might follow the roadside for dreary miles.

When planning "In the Shade of the Elm," I decided that the picture should show the protective quality of the great tree, with the small house snuggling at its roots. A good deal of control work in the darkroom was done on this print, with a local reduction agent used to bring out the transparent quality of the leaves on the tree. Also, the sky between the branches was darkened so as not to intrude too insistently.

The possibilities in photographing houses are almost endless. Your portfolio can include not only assorted pictures of houses, but also specialized groups or series that show houses of a certain style or region, that picture them at various seasons of the year or at different times of day, or that concentrate on various parts of houses—chimneys, doorways, windows, porches, and so forth.

If these remarks have encouraged you to go out after some pictures of houses, do not let a lack of special equipment act as a brake on your enthusiasm. None of the pictures illustrating this article required anything more than a standard camera, film, exposure meter, and filters.

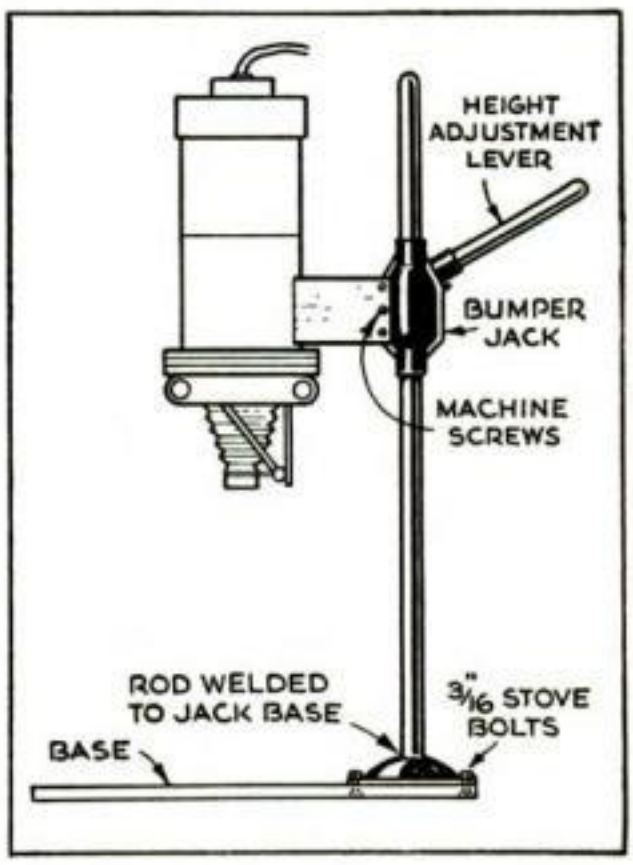
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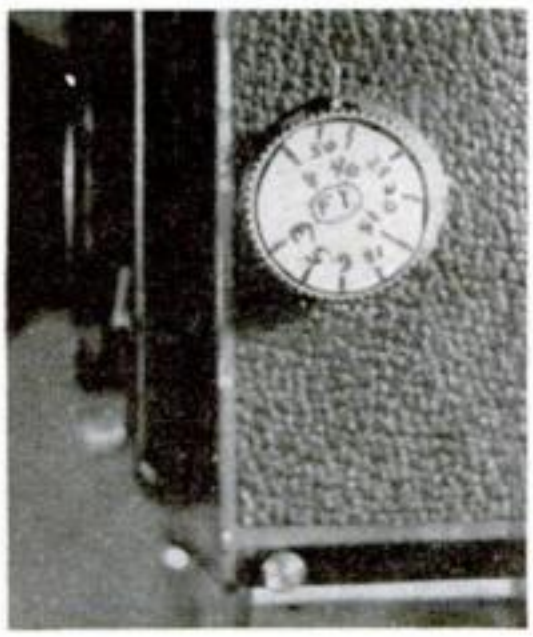




QUANTITY AND QUALITY are the keynotes of the photographic work done at the Navy's lavishly equipped Photo Science Laboratory, in Anacostia, D. C. Since photography has become increasingly vital in modern naval strategy—and since it is particularly useful in reconnaissance and in charting the coral reefs and sand bars surrounding little-known Pacific atolls—the Navy does not skimp on the men, money, and equipment it assigns to this branch of the service. In the photos above, note the elaborate enlargers and the battery of print-washing tanks that are in use.

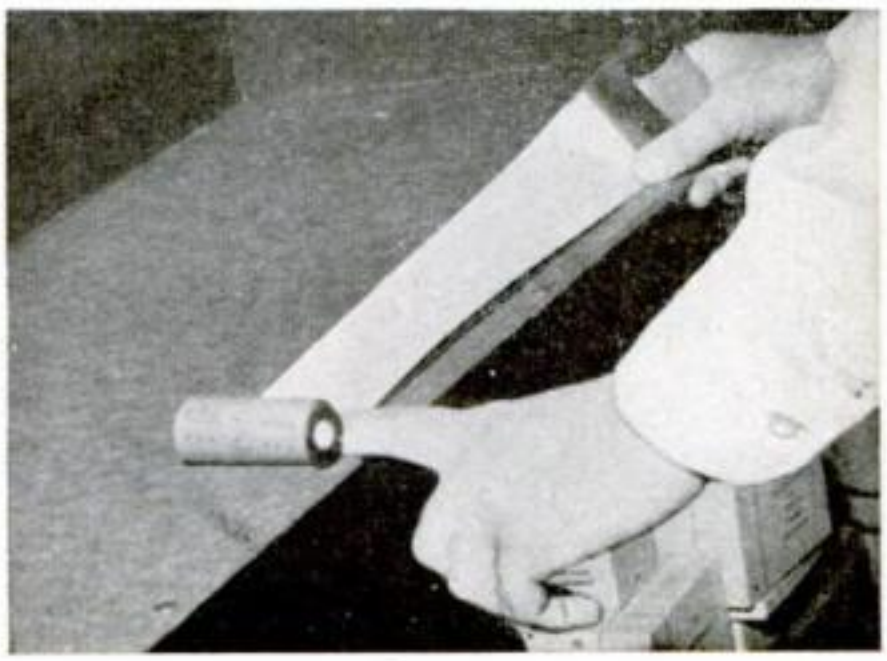
A BUMPER JACK serves as an excellent stand for a homemade enlarger. Mounted as shown at the right, with its base permanently attached to the upright by welding, the jack gives a steady support to the housing. Height is varied by moving the jack lever.—HARRY SNOW.





SHARPER NEGATIVES are often the result when the user of a foreign-made camera converts the focusing scale from meters to feet, since many persons find it easier to estimate a distance at, say, 10′ rather than three meters. The new calibrations can be checked by focusing over measured distances, and may be marked on or cemented to the camera.—L. H.

CUTTING ROLL FILM in total darkness, as when certain negatives must be segregated for sensitizing or special development, may be done by using as guides thumbtacks that have been placed on the top of the darkroom working surface. They are spaced by measuring a previously developed roll and by driving a tack on the line of separation between each negative. Then, whenever it is later necessary to give separate handling to a particular negative, the undeveloped roll can be cut apart without damaging exposed areas.—HARRY F. LEEPER.



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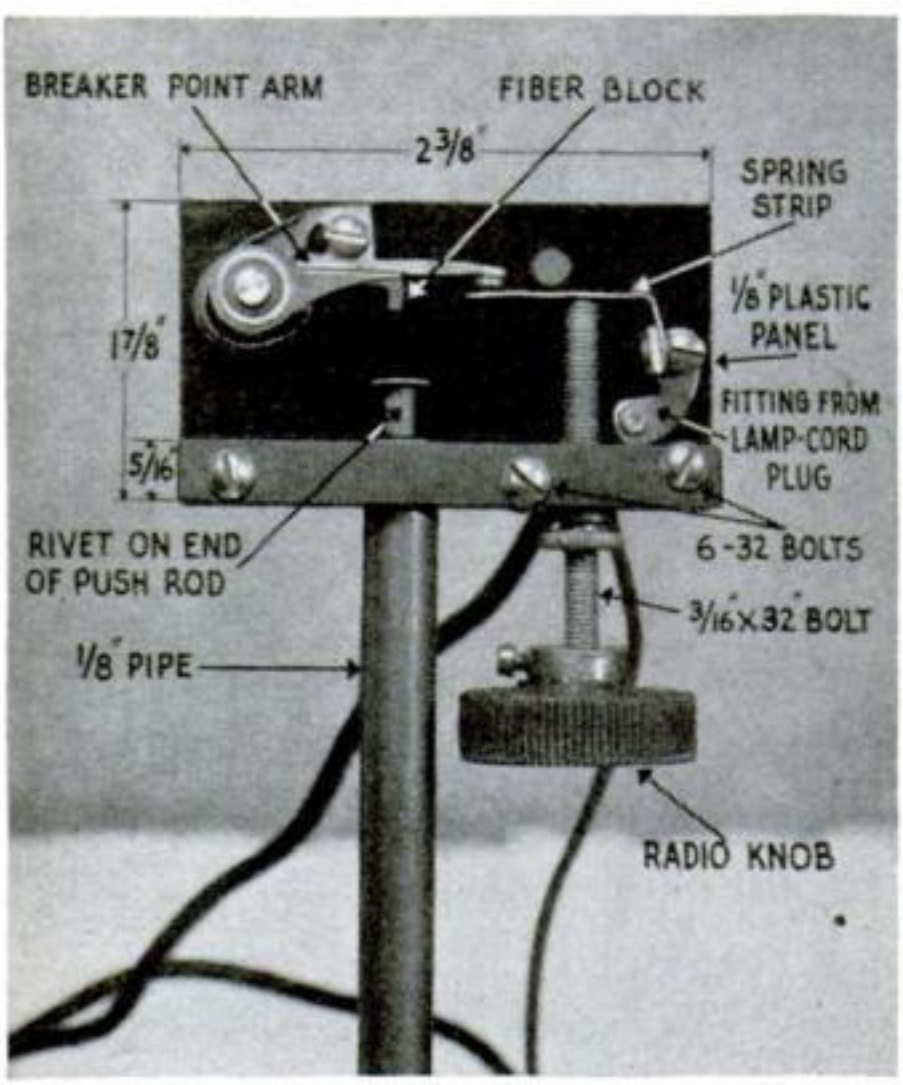
SENSITIVE HIGH-TEMPERATURE

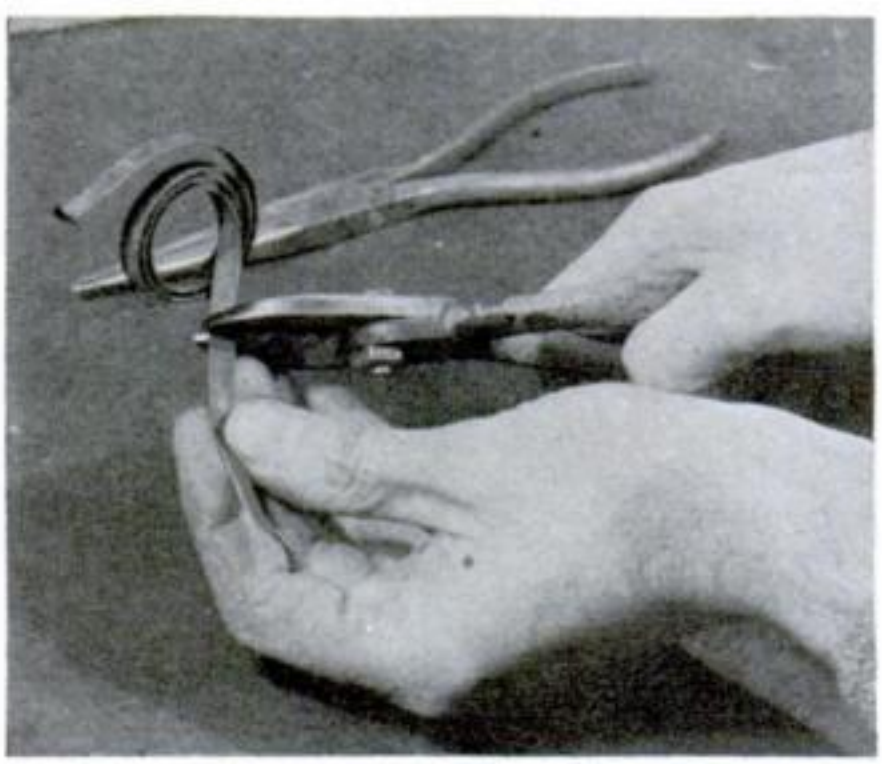
WILL CONTROL AN ELECTRIC TEMPERING FURNACE

By WALTER E. BURTON

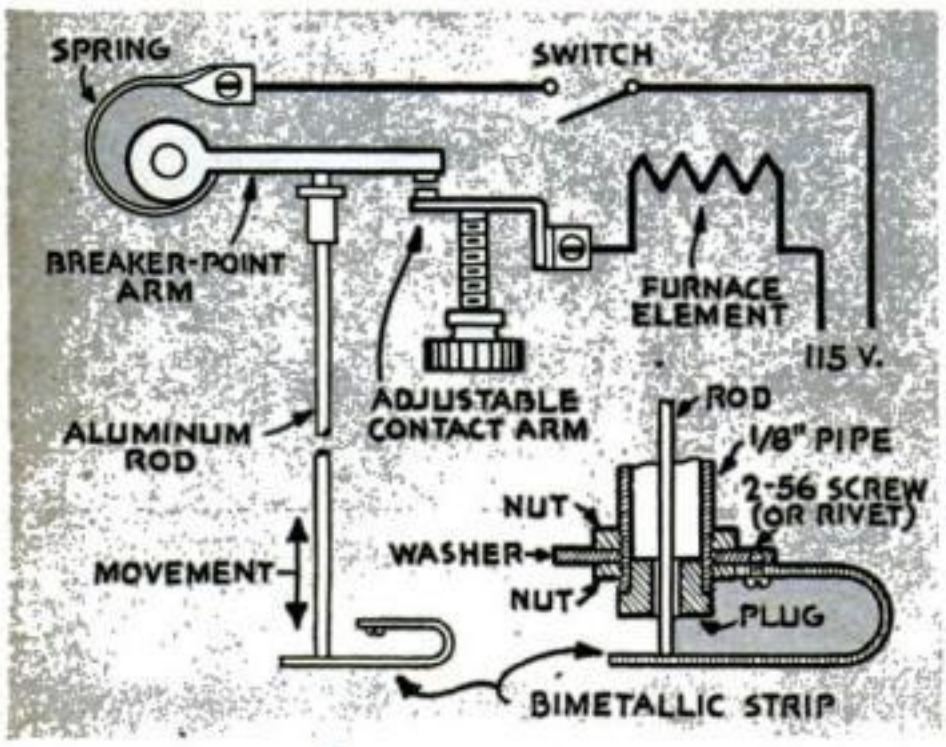
A HOMEMADE thermostat that is able to hold an electrical tempering furnace within a few degrees of a selected temperature may be readily built from old auto parts and other scrap. The key part of the device is a bimetallic strip cut from a junked car thermostat. Mounted at the lower end of a pipe projecting into the furnace, this strip actuates a rod running through the pipe, opening or closing the heating circuit by moving an automobile breaker-point arm. The device is adapted for use in a resistance furnace, up to about 1,000 deg.

The thermostatic spiral spring, obtainable in most junk yards, should be of the kind used in manifold dampers or automatic choke controls rather than in cooling systems. Snip off a piece about 3½" long and bend in a U shape with one arm longer than the other; then insert the piece for a moment in a gas flame to make certain that it has been bent in such a way that heat causes the arms to move together. Rivet or bolt the shorter arm to a large washer that is mounted between two nuts at the end of a ⅛" brass or iron pipe. The free end of the bimetallic strip should center under the pipe opening. A sheet-metal shield may be placed





The bimetallic strip, cut from a thermostatic manifold control in a junked car, is pictured above, while the photo below shows the way it is mounted. At the left below, the operation of the device is indicated schematically. Directly at left is the circuit-breaking mechanism





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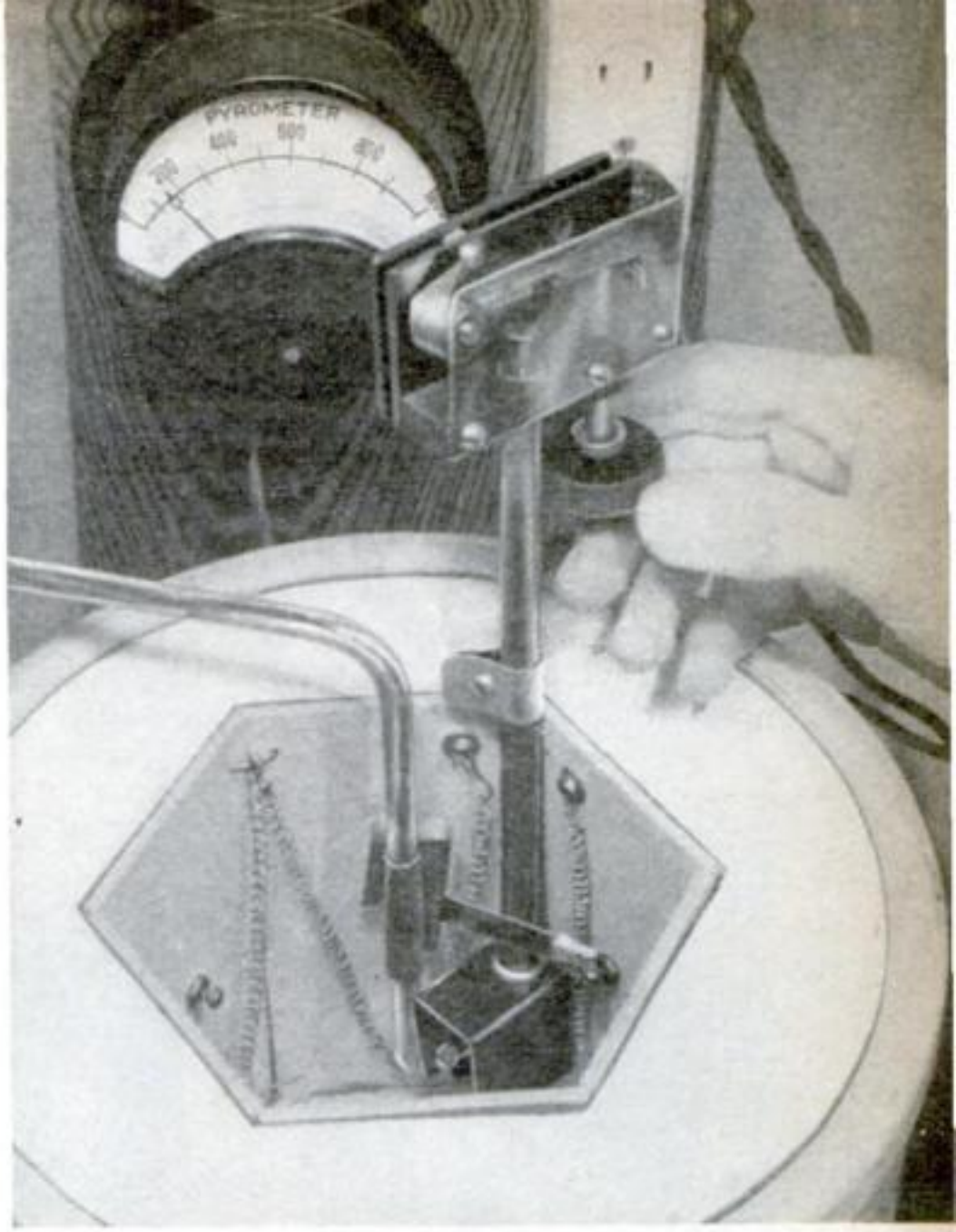
THERMOSTAT
WITHIN CLOSE LIMITS

around the strip to protect it from bumps.

The circuit-breaking unit, which is mounted at the upper end of the pipe, consists of a small plastic panel fitted with an adjustable contact and a breaker arm taken from an auto distributor. The arm is attached so that its fiber bearing surface is directly over the pipe center and its contact point over the adjustable contact. Along the lower edge of the panel, bolt on a plastic strip that is tapped to take the adjustment screw. Equip this screw with an old radio knob, and insulate it from the spring-brass contact by means of either an insulating cap or a piece of fiber taped to the arm it bears against. Cover the exposed side of the panel with a piece of mica or plastic.

The push rod running through the pipe should be as light as possible. The one shown is an aluminum welding rod with its upper end forced into a hollow-shank rivet. Metal plugs are driven into both ends of the pipe and holes drilled in them that are large enough to take the push rod without binding.

Connect the thermostat in series with the furnace and turn the adjustment knob until the points are in firm contact. Use a pyrometer or thermometer for calibration; when it indicates the temperature at which you wish the circuit broken, turn the control knob back until the points just separate. If you find that there is more than a 5-deg. variation above or below the selected temperature, inspect the push rod for binding and if possible use a lighter rod. The thermostat usually works best when it is mounted vertically, but it may be mounted horizontally if the breaker-arm spring is strong enough to move the push rod back when the bimetallic strip relaxes pressure. If the furnace used draws over 5 amp., more rugged contact points of the kind made for heavy-duty trucks will have a longer life.



Use a pyrometer or a thermometer to set and check the accuracy and working cycle of the thermostat

LOAD ON LIGHTING CIRCUITS [*ELECTRICITY*]

The latest National Electrical Code, 1940 edition, in its specifications for a 15-amp. branch circuit, does not mention the number of connecting outlets it may contain, the only restriction of this nature being that the load shall not exceed 15 amp. at any time. However, the wiring must be done with No. 14 wire in an approved manner, and the fuses should not exceed 15 amp. Although the outlets can have permanently connected lamp holders (sockets) and receptacles rated at not more than 15 amp., it is of the utmost importance that appliances should not have an individual rating of over 12 amp. And incidentally, but little extra could be used with such an appliance without blowing the fuse.

If the circuit also supplies lamps and other portable appliances and the appliances are of fixed construction, their rating cannot exceed 6 amp. If it is exclusively for motor-operated appliances, however, the rating can be as high as 12 amp. Should the circuit supply only fixed appliances other than motor-operated types, a 15-amp. fixed appliance can be connected.

POPULAR SCIENCE MONTHLY SHOP DATA

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ROTARY RECTIFIER

Supplies Direct Current for Charging Storage Batteries

By HAROLD P. STRAND

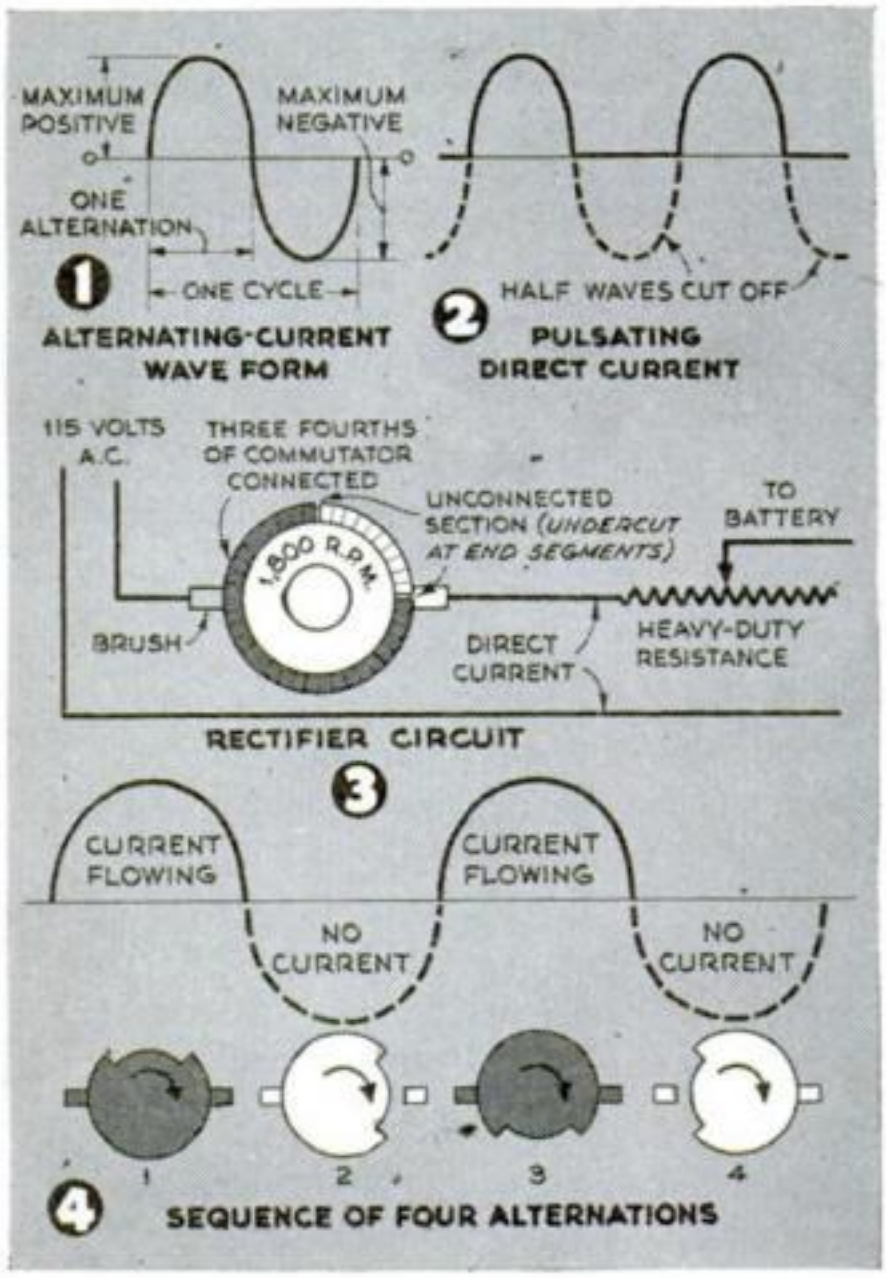
FINDING your auto battery discharged is a nuisance at any time—and one that is likely to occur oftener now under our reduced driving program. This is a particular hardship on owners of some recent cars, who may find hand-cranking difficult. It is no wonder, then, that home battery chargers have commanded increasing interest.

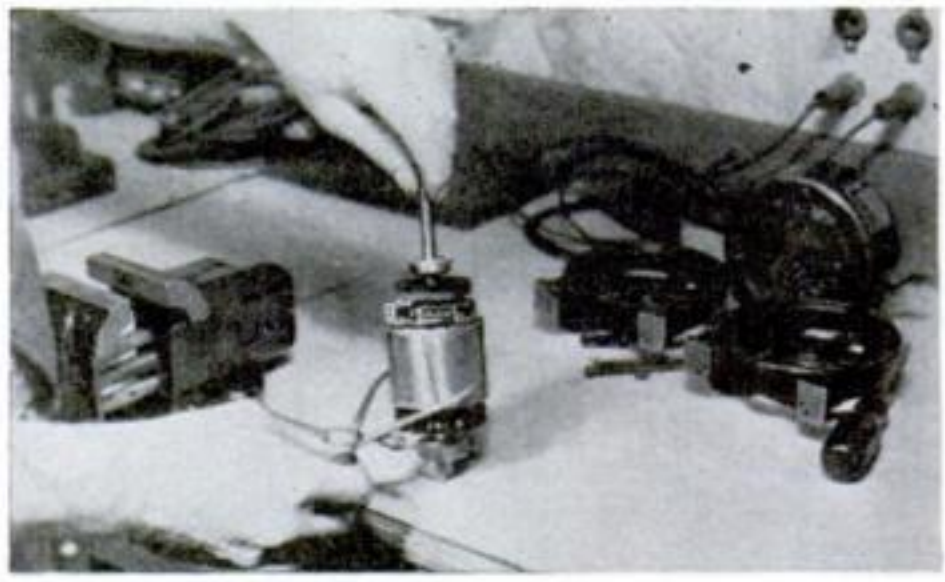
Many drivers are familiar with the dry-disk, chemical, and mercury-arc rectifiers used, but here is a simple apparatus utilizing a fractional-horsepower motor that changes A.C. into D.C. and will charge an auto battery in a few hours. A 1/40 to 1/25-hp. synchronous motor is preferable, but a small split-phase induction motor can be converted for the job if it is rated at 1,725 to 1,750 r.p.m. Also needed are a heavy-duty transformer that will deliver 15 volts at 8 to 10 amp. from the A.C. line, an auto cutout, an ammeter, a 1¾" diameter bar commutator ⅞" wide, parts to make brush holders, some resistor wire, and a porcelain tube.

Current for charging a bat-



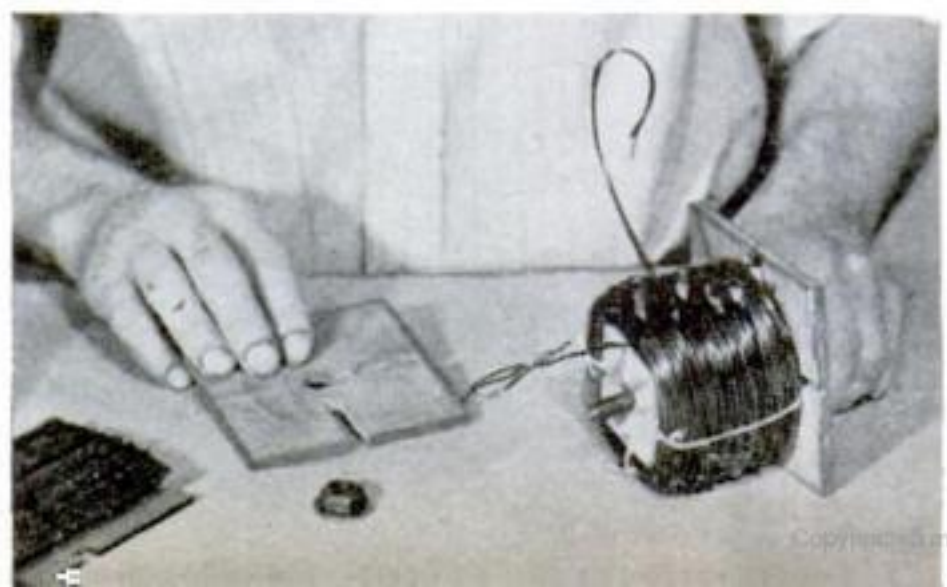
Connected to a house A.C. line, the homemade charger restores a battery at a rate up to 10 amp.





Four flats are filled across the induction-motor rotor in making the unit synchronous. Distance between each two opposite flats must be the same

Wound on a wooden form, the transformer coil is provided with loops in the wire to serve as taps



tery must flow in only one direction. A.C. is converted into such unidirectional current by cutting off alternate half waves (Figs. 1 and 2). With the rotary rectifier, A.C. is converted to pulsating D.C. by a commutator having three fourths of its segments joined with a band of hard solder or brazing metal and the remaining quarter unconnected, as in Fig. 3. The commutator may have 32, 36, or 40 bars, or any number divisible by four.

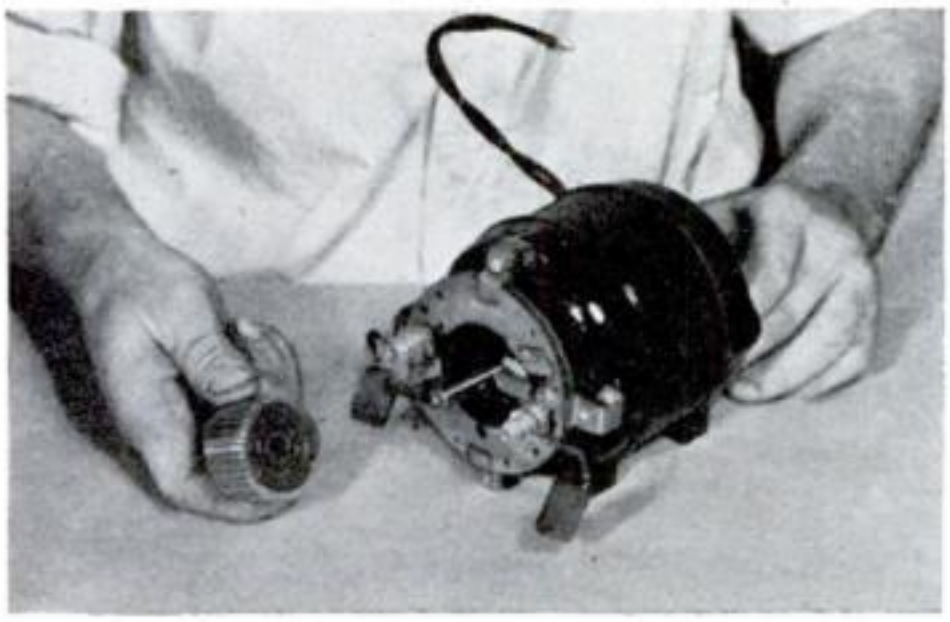
Join the segments at the risers or the back edge, and undercut the mica deeply between the end segments of the joined sections and those left unconnected. On the shaft of a motor running at synchronous speed of 1,800 r.p.m., the commutator will interrupt A.C., connected with the brushes in series on one side of the line, every time its unconnected segments pass one of the brushes. The result will be pulsating D.C., as shown in the wave diagram in Fig. 4.

If a synchronous motor is unavailable, a split-phase induction motor of about the same horsepower can be adapted by making some simple changes in the rotor. After removing the rotor, file four flats across its laminations at exactly 90-deg. points, as in Fig. 5, being careful to lay them out correctly and being sure *not* to file the copper end rings. The width of the flats depends upon the individual rotor, but generally it should be about half that of an unfiled space. Check the balance after assembly and make corrections on the position of the flats, if necessary, for if they are not spaced exactly, the motor will run out of balance.

The theory in changing the rotor is that the flats crowd the flux into the spaces between them, thus making definite poles that cause the rotor to pull into synchronism. Test the motor with a tachometer after assembly. The speed must be exactly 1,800 r.p.m. and should remain constant under moderate load.

Figure 6 shows how the brushes are mounted. The plastic, fiber, or hard-rubber brush ring is adjustable, being held between clips bent from 1/8" flat copper or steel stock that are attached to the motor housing. Two old brush holders from an auto starter or generator can be used to hold the carbon brushes, but they must be installed in perfect alignment.

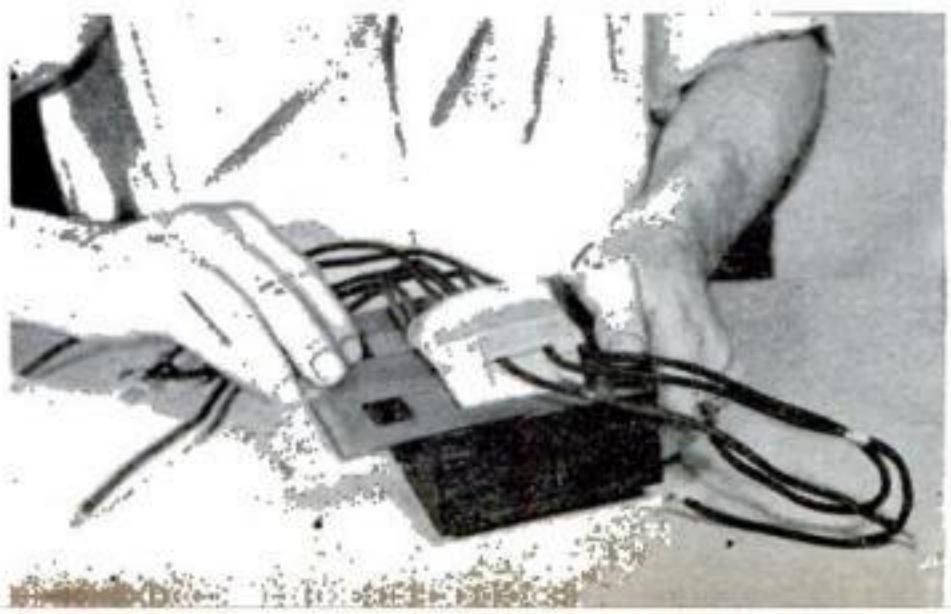
If operating cost because of current loss is no object, the transformer can be left out of the circuit and a heavy-duty resistor, capable of carrying about 10 amp., connected in series with one side of the line to the battery to limit current (Fig. 3). But if the saving of current is important, a transformer should be used. This reduces the current draw to 3 or 4 amp. for a 10-amp. charging rate. An autotransformer, connected in the ground side of the line as in Fig. 7, is simplest to use. It will reduce the 115-volt A.C. to 15 volts, and the small resistor (Fig. 9)



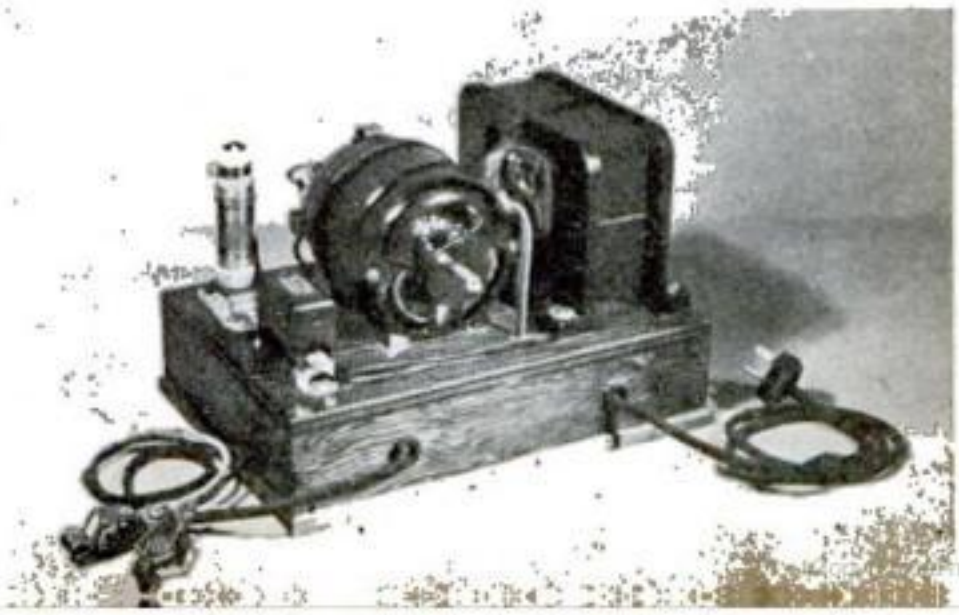
Three fourths of the bars of the commutator are joined with hard solder and the remaining part is left free. This cuts off half of the A.C. wave



Both brushes must be in perfect alignment on the motor. Their position can be adjusted by loosening two machine screws and then moving the plastic ring



After leads are soldered on, the coil is taped, and the E-section laminations are put in place



Here is the completed unit as seen from the rear. Wiring connections are concealed in a boxlike base

in the battery circuit will be large enough for further regulation.

A suitable autotransformer may be built from materials in the junk box if a serviceable one of the required capacity is not at hand. Start with the core of an old radio power transformer or any with a cross section of about 3¼ sq. in. Remove the coil. The core shown in the photographs had a center-leg measurement of 1 5/8" by 2", so a wooden form was made this size, and a new coil consisting of two No. 16 enameled magnet wires wound in parallel was wound on the form in the lathe at slow speed. A total of 180 turns will be needed on a core of these dimensions, and a tap at the 24th turn should give 15 volts (Fig. 8). It is well to bring out taps or loops at the 22nd and 25th turns also so the one nearest the required voltage can be used. Taps provided at the 30th, 45th, 70th, 90th, and 125th turns will make the transformer useful for other purposes.

Use a piece of sleeving over each loop as the winding progresses, to insulate it from adjacent turns, and keep all taps as near as possible to the same side of the coil. When completed, solder No. 16 flexible leads to the taps and at the start and finish of the coil. Then be sure to identify them with paint or other suitable means.

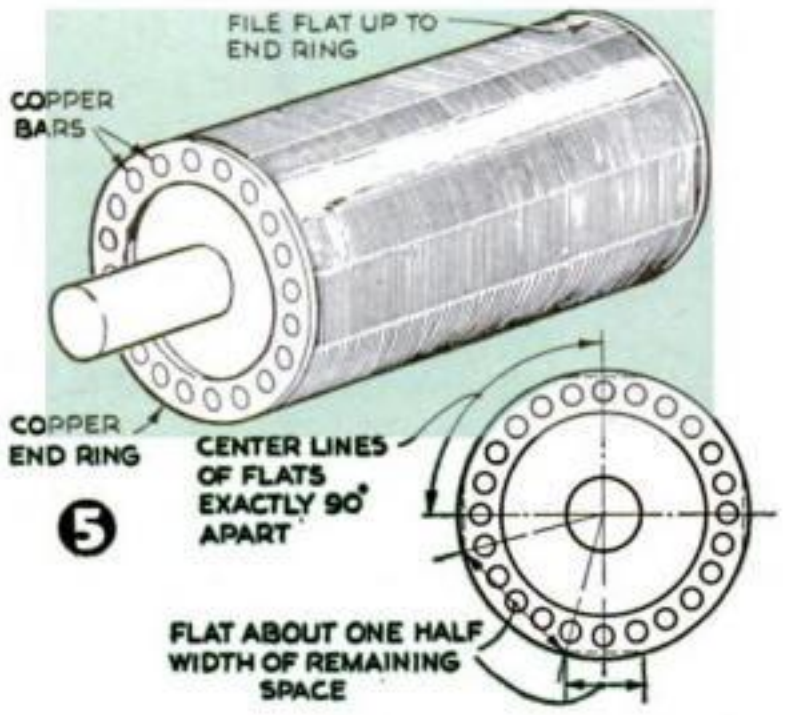
In figuring the voltage, consider the 115 volts impressed across the coil of 180 turns as an average value. Dividing the volts by the turns gives a value of approximately .64 volts per turn. It is easy then to determine how many turns will be needed for a tap to put out the voltage desired.

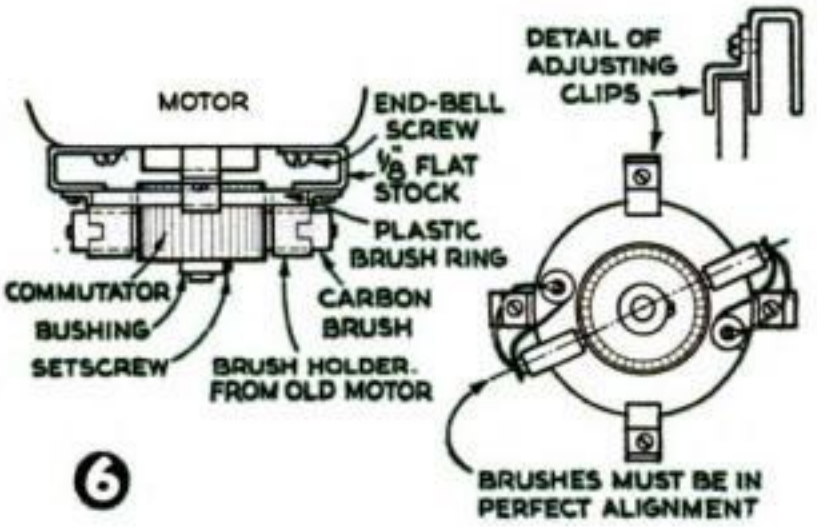
Laminations should be placed carefully so as to alternate the E-sections and single pieces in successive layers, and when all have been placed, they should be tapped lightly into line with a wooden block and clamped tightly. One method of clamping is to use two iron frames bent out on one side to provide feet and held together with bolts, as indicated in the photos. A wrapping of cotton tape is advisable after the coil has been dipped in insulating varnish, but be sure the soldered joints under the tape are well insulated.

In the battery line in Fig. 7 is an automobile cutout relay that will close only when the direction of the current is correct and will remain open and vibrate when the current is reversed. In addition, when the line switch is opened, the cutout will also open and prevent discharge of the battery through the rectifier and transformer. With chargers of this type, a reversal in the polarity of the battery leads takes place if the current is interrupted and then restored with the motor pulling in on the reverse D.C. half wave. Opening and closing the line switch a few times will make it pull in again on the desired half wave. For this reason it is not a good idea to leave the charger unattended, or working overnight, since the warning buzz might not be heard.

Those who wish to make the charger fully automatic may purchase or make a reverse-current relay that will cut in the battery line to operate on the reverse current. However, it is usually possible to charge most batteries during a time when someone will always be within earshot.

In either case, the charger should be supplied through a fuse in the live side of the line. One with a low rating such as 6 amp. will do, but better yet is a 4-amp. time-lag fuse. Both provide protection against short circuits and overloads.





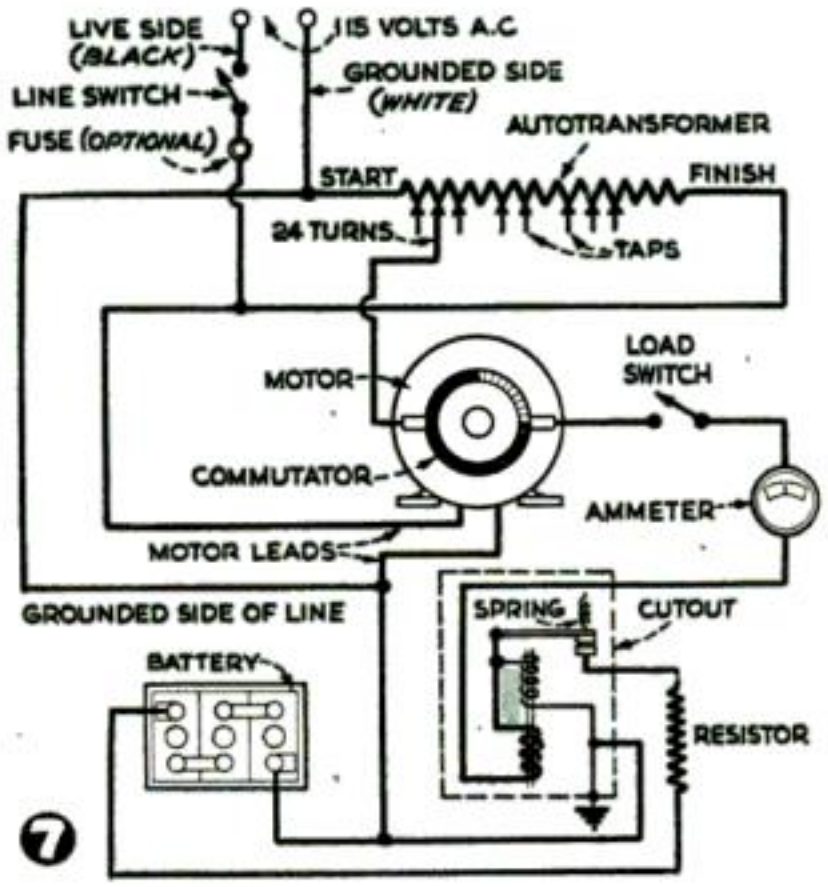
An inverted wooden box, rather flat, will serve satisfactorily as a base that will house and conceal the wiring as well as provide a panel for an ammeter and toggle switches. Almost any light stock—plywood, if you have it on hand—may be used. It may be stained and varnished as desired. Mount the transformer first on one side, as indicated in the photos, and take the leads through drilled holes to the inside of the box. Next, mount the motor at the center, and take the input and brush wires through similar holes into the box. The small resistor and cutout

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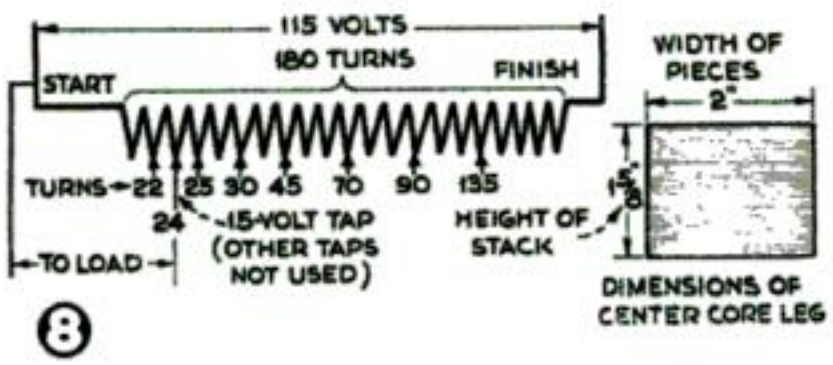
are mounted on the other side of the motor, their wires also going into the box, while the ammeter and toggle switches are set in the front panel. Connections, as shown in Fig. 7, are then made inside the base.

Test the transformer first by connecting it temporarily in the line and using a low-reading A.C. voltmeter to check voltage from the start of the coil and from the 24th tap or the one most nearly giving 15 volts. Then connect this tap to one brush. Let the tracer-marked wire in the line cord be the grounded side of the line direct to the battery in order to avoid shocks when touching the battery clips. The line switch cuts in on the live side of the line. Be sure to use a polarity plug and A.C. socket that can be plugged together in only one way. Solder all joints and tape them well; then board up the bottom of the base.

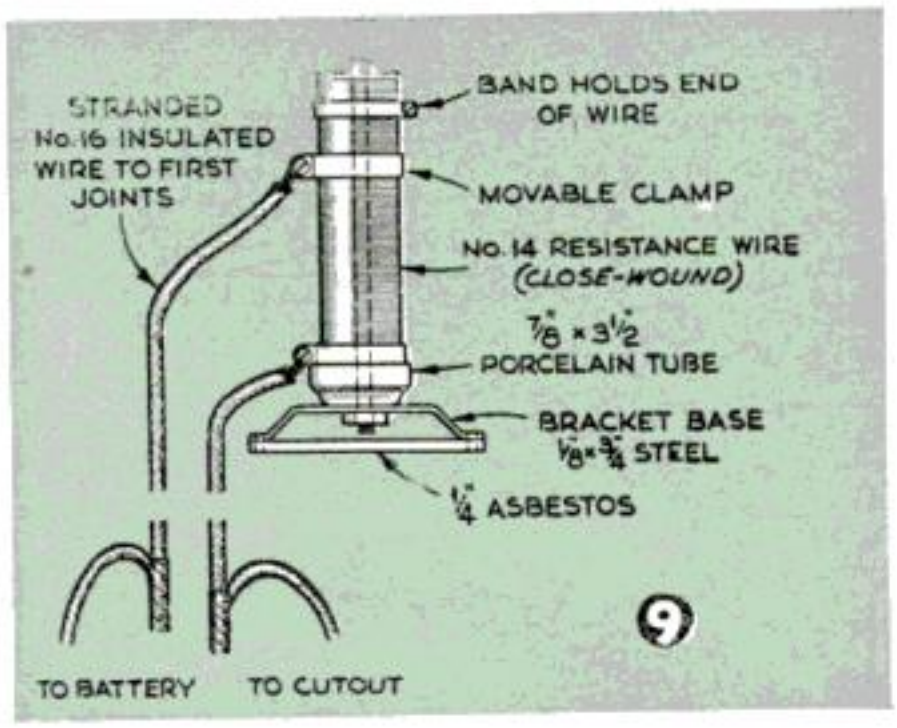
Now, close the line switch to start the motor, leaving the load switch open and the battery unconnected, and allow a little time for the brushes to wear to a good fit, using a commutator stone on them if one is available. With the battery still out of the circuit, immerse the battery clips on the wires in a tumbler containing water and a teaspoonful of salt, and then close the load switch. The cutout armature will vibrate loudly and, therefore, should be held down firmly with one hand.



7



8



9

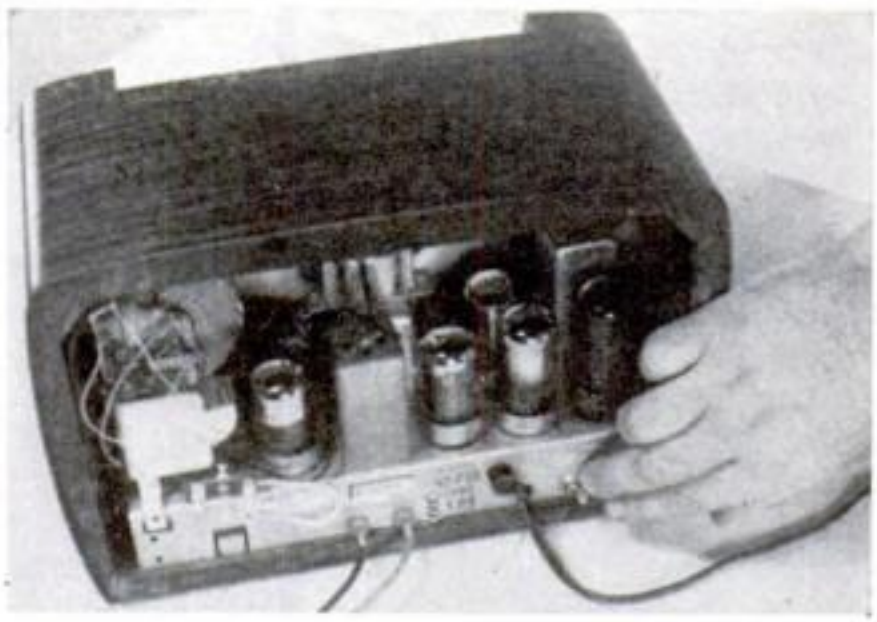
Bubbles will collect around one clip in the salt water, indicating the negative side. Touch the clips together for an instant to see which way the ammeter reads. If this is up the scale toward charge, mark the clips for positive and negative. Should the ammeter read down scale toward discharge, open and close the line switch quickly a few times to make the motor pull in on the other half of the wave. After marking the clips, always connect the positive side to the positive battery terminal.

Cutout buzzing should stop when the battery is connected; but if some buzzing continues, bend the spring slightly to change tension and perfect the adjustment. Should the brushes spark under load when first started, correct their adjustment until the tendency is halted. Keep the commutator in good condition by an occasional cleaning with fine sandpaper while it is rotating, and inspect and clean the cutout points occasionally. The cutout can be checked with the cover off by opening and closing the line switch, which should open and close the points.

Adjustment can be made in the charging rate to the battery by moving the clip on the resistor. The nearer it is moved to the base, the less the resistance and the higher the rate of charge. With the apparatus described here, it is not advisable to exceed a 10-amp. charge, and it is better to keep it between 6 and 8 amp. However, the rectifying commutator itself is only limited in load by what the brushes and commutator will carry. It is possible to build heavier regulating equipment and use a heavier transformer and wiring, and then to supply considerably heavier current. By increasing the voltage of this setup with a higher transformer tap, you would be able to charge at one time several batteries connected in series. The smaller job, however, is ample for recharging most automobile batteries that have run down owing to infrequent use in these days of gas-rationing.

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Two jacks and a toggle switch, installed on the chassis of a table radio as shown above, permit the small set to be connected to the speaker of a console model by wires leading from the jacks

Better TONE from Table Radios

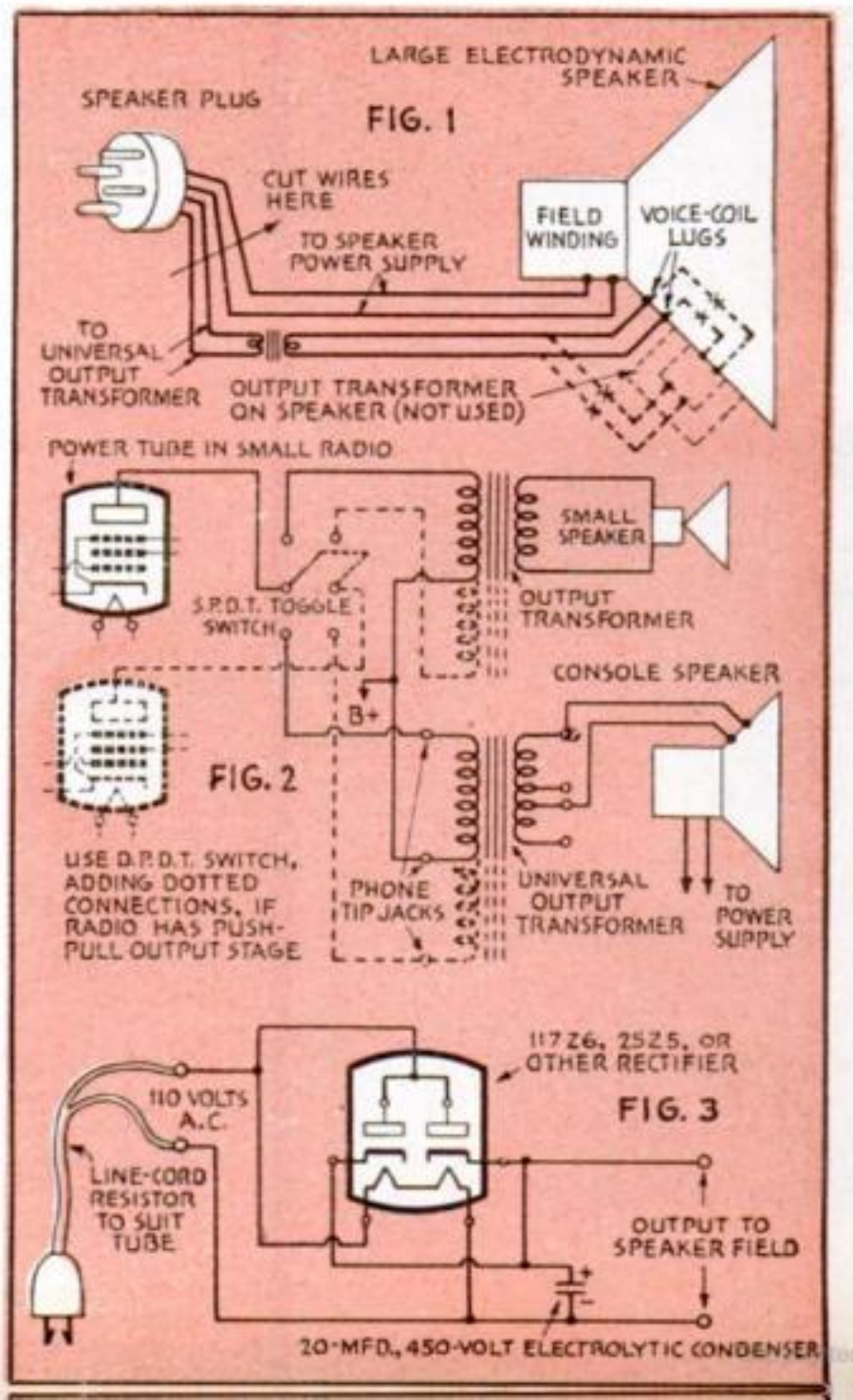


HOW A DISCARDED CONSOLE SPEAKER CAN BE CONNECTED TO ANY PORTABLE RECEIVER

HAVING smaller speakers with less baffle area, popular table radios are likely to have tones inferior to those of console models with large speakers. Such old console models may be found still preserved but long since disused in many homes. It is not difficult to connect their large speakers to small radios for use either permanently or only during programs for which good tonal quality is desired.

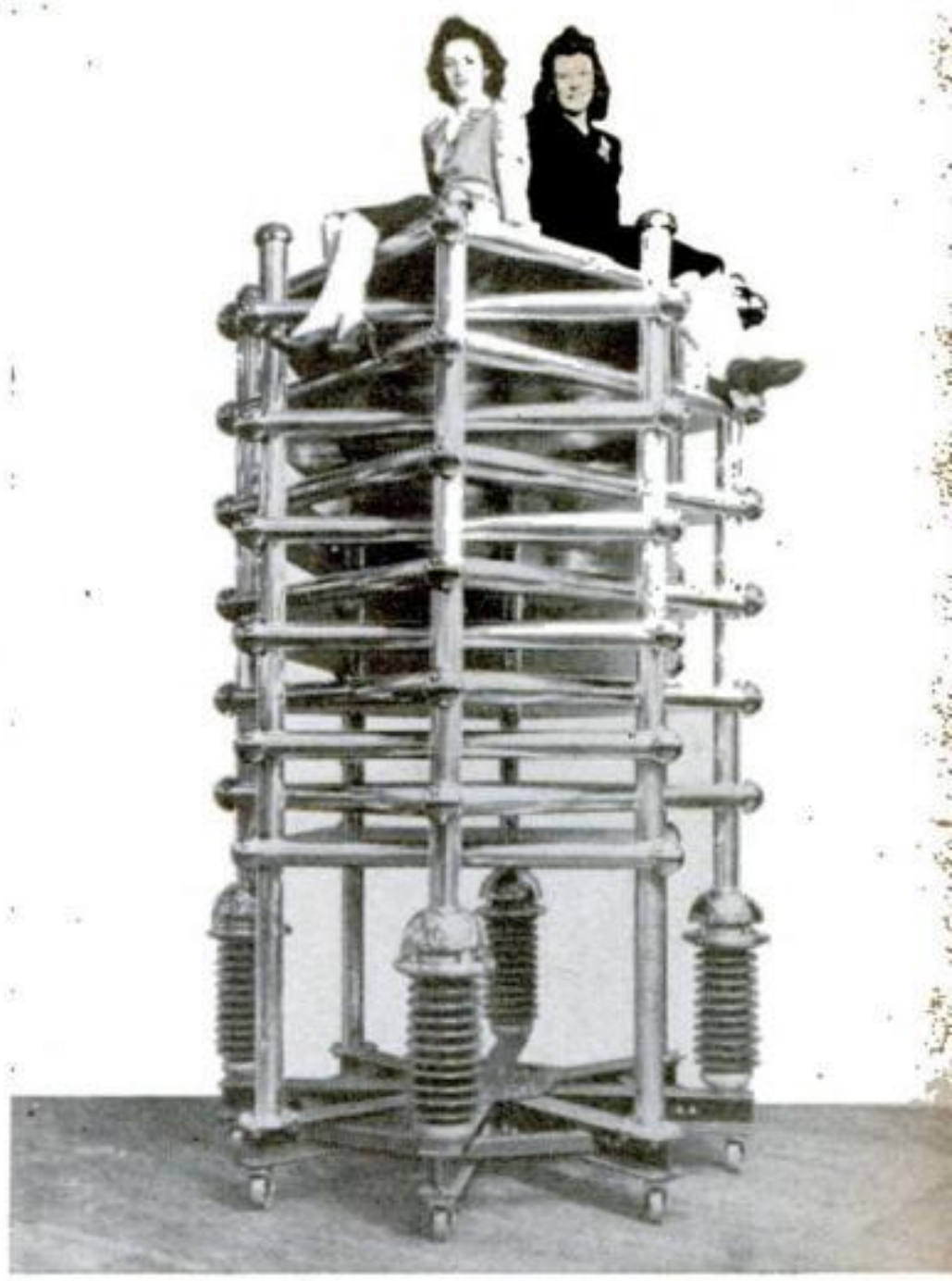
At the rear of the chassis of the small receiver mount a toggle switch and two insulated jacks—three jacks if the set has push-pull output. This switch connects either of the two speakers to the output circuit of the small radio. Two wires leading from the jacks are connected to the voice coil of the large speaker through an output transformer that will match it to the output circuit of the small radio. If this speaker is already equipped with an output transformer, disconnect its original voice-coil leads and solder the leads from the new transformer to the lugs on the voice coil (Fig. 1). Connect the switch and jacks inside the small set as in Fig. 2.

If the console speaker is the dynamic type, its field coil must be energized by a simple rectifier like that in Fig. 3. This is not necessary with a magnetic speaker.



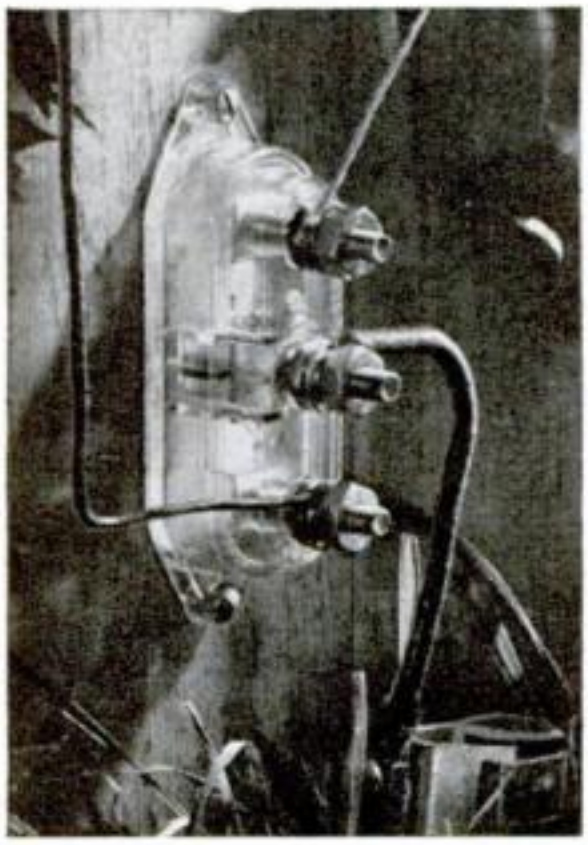
radio ideas

THIS GIANT CAPACITOR, a 200,000-volt air condenser with a capacity of 2,500 mmfd., is used as a phantom antenna for testing high-power transmitters. It has 12 hollow plates made of 16-gauge sheet steel and plated first with copper and then with nickel to improve conduction. Shields at the ends of each plate prevent dissipation of electricity. The supporting insulators were designed for a 400,000-volt dry flashover. Despite its 10′ height and 2,000-lb. weight, the unit can be moved easily on its casters or can be taken down completely or assembled in a single day. It was built by the Federal Telephone and Radio Corporation, and is used to test large transmitters at full load without radiating any signals.





RAPID ELECTRONICS CALCULATIONS are possible with the new R.F.-resonance and coil-winding slide rule shown at the left. With it can be determined such values as inductance, capacitance, and the frequency components of series and parallel tuned-R.F. circuits and also inductance, turns per inch, wire type and size, and coil diameter and length of single, layer-wound, solenoid-type R.F. coils. All combinations are included for coils ranging from ½" to 5½" in diameter and ¼" to 10" in length, and these are accurate within approximately 1 percent.



LIGHTNING ARRESTERS are now being housed in a shatterproof transparent plastic for the U. S. Army Signal Corps to protect them from weather, dirt, and insects. A small neon tube visible inside the housing glows in the presence of electrical discharges during a thunderstorm to indicate a satisfactory connection betwen aerial and ground.

MIDGET VACUUM TUBES continue to be important where space is limited and economy of power is necessary. The tubes shown at the right come in two .625-volt filament types, one a 25-milliamp. amplifier and the other a 50-milliamp. output tube. They are made without bases since soldering the leads directly to the tube circuits saves space.



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HOME EXPERIMENTS



SILENCE IN A VACUUM can be demonstrated with a glass flask and a small sleigh bell. Hang the bell on the end of a length of dowel or glass rod that can be pushed through the hole of a snug-fitting flask stopper; then put a little water in the flask, boil it long enough for steam to drive out the air, remove it from the heat, and fit the stopper in as soon as the steam stops expanding. Cool the flask with running water and shake it near your ear. You will barely hear the bell tinkle, the steam having produced a partial vacuum—sound waves will not travel through a vacuum. But let air in and again shake the flask, and the tinkle will be heard clearly.





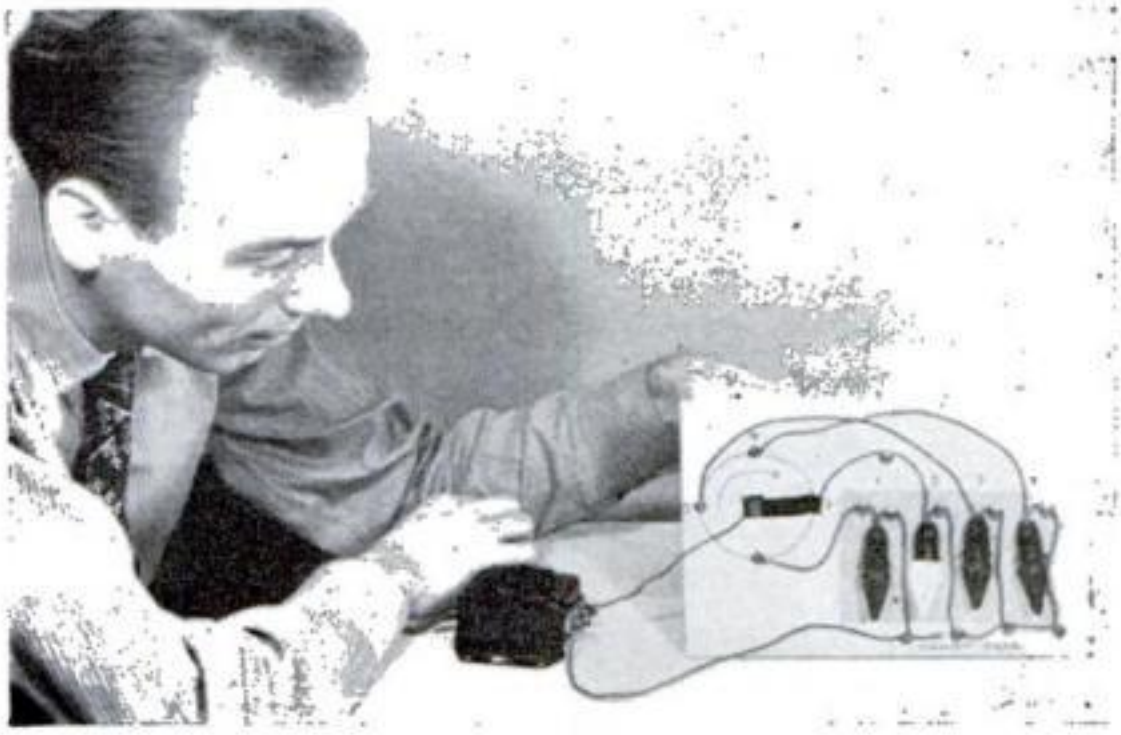
HOW SMOKE RINGS ARE MADE may be shown with an empty cardboard salt box and a few drops of ammonia and hydrochloric acid. Remove one end of the box and cut a clean ½" hole in the center of the other. Glue two double thicknesses of blotting paper next to each other on a strip of cardboard, and put three or four drops of acid on one and an equal amount of ammonia on the other—the reaction of their fumes makes a white smoke. Put the smoke generator in the box, and seal the wide-open end with heavy paper held by a rubber band. You will quickly learn the technique of making rings. A sharp tap on the paper shoots out a thin, small, high-velocity ring; an even push ejects a thick, slow-moving ring. All turn inside out as they travel.

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THIS NOVELTY MOTOR is made with a bar magnet and a box top partly filled with mercury and supported on a tumbler. Suspend copper wire from the hooked end of a stiff wire bent as shown and attached to one pole of a dry cell. Dip a wire from the other pole into the mercury. Repelled, the suspended wire spins around the magnet; reverse connections, and it spins the other way.

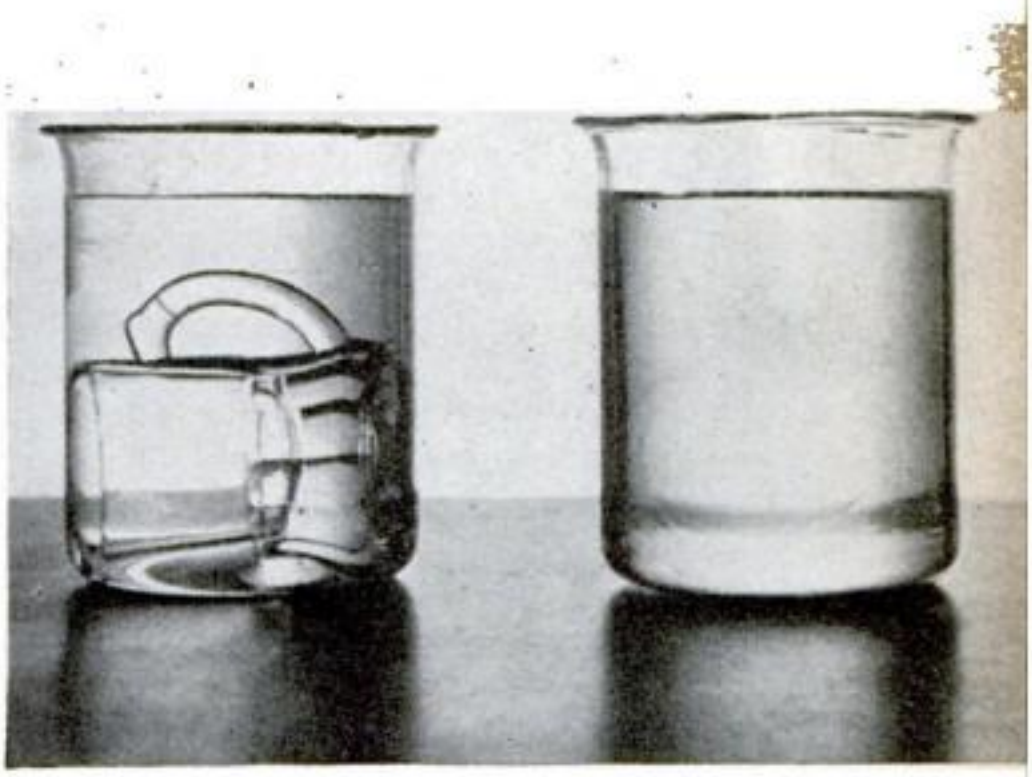


CAR-DISTRIBUTOR ACTION can be demonstrated with a rotating switch wired, as below, to Christmas-tree bulbs representing spark plugs. On a car, the brush makes one revolution for two of the crankshaft, firing a plug as it touches each stationary contact point. A common sequence of firing for a four-cylinder engine is 1, 3, 4, 2.

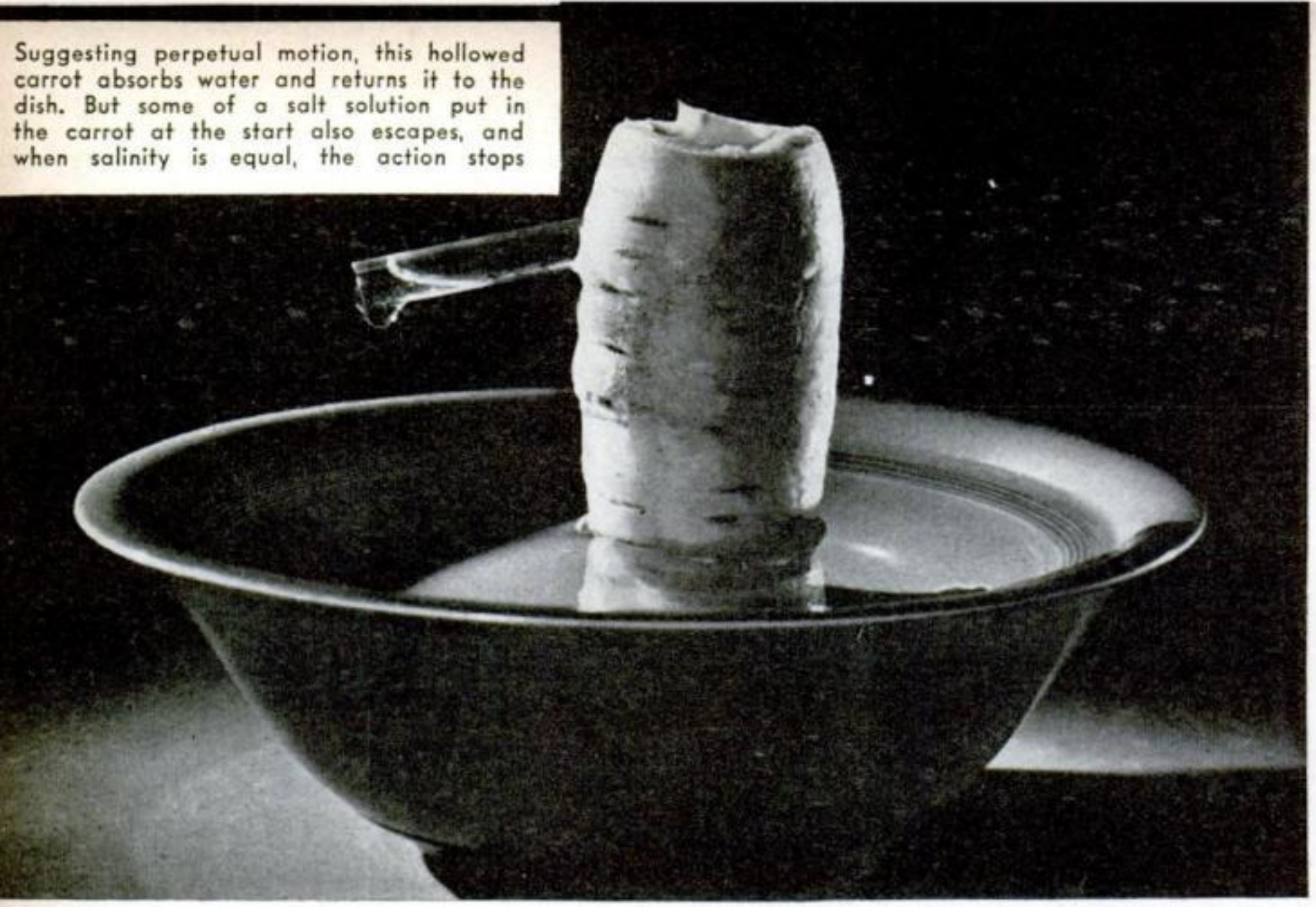


GLASS WILL DISAPPEAR when immersed in a liquid, even a clear liquid, that has its same index of refraction. Ordinarily glass is seen because it reflects light from its surfaces and light is refracted within it. The amount the light is refracted is its index of refraction. Tetrachlorethylene, a dry-cleaning fluid, is one liquid that blends so perfectly with glass that glass covered by it can't be seen. Chlorobenzene is another. For a demonstration, put a small glass in clear water and another in one of these liquids.





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Suggesting perpetual motion, this hollowed carrot absorbs water and returns it to the dish. But some of a salt solution put in the carrot at the start also escapes, and when salinity is equal, the action stops

What Is Osmosis?

LONG A MYSTERY OF PHYSICAL CHEMISTRY, THIS STRANGE MOLECULAR FORCE CAN BE DEMONSTRATED IN YOUR HOME

By Richard F. Trump

BY DROPPING an egg into acetic acid, leaving it until the shell is completely dissolved, and then transferring the membrane-covered egg to clear water, it is possible to observe one of the most mysterious forces known to science.

Osmotic pressure causes the egg to swell to the bursting point.

This is the force that is able to build up pressures many times that of the atmosphere and send water to the highest leaves of a giant sequoia tree. It carries molecules of digested food through the walls of the blood vessels to be distributed to the body cells. It enables a fish to live without drinking, and causes overripe plums to burst on the tree during damp weather.

This mysterious process is important to chemist, physicist, and biologist alike. Although they have not yet settled many of the problems it presents, they are able at least to offer a workable theory that fits most of the facts.

The molecules of any liquid are in constant motion. If you were able to look into a glass of water with enormously magnified vision, you would see particles of water—each composed of an atom of oxygen and two of hydrogen—constantly bombarding the sides of the glass. If you partitioned the glass with a membrane such as the one on the shell-less egg, you would see some of the moving particles passing through tiny pores of the membrane to the opposite side.

As long as the number of molecules traveling through in each direction is equal, there is no change in level; but see what happens when a little salt is dissolved on one side. Molecules of sodium chloride, larger than those of water, can't go through the pores. As the salt crystals dissolve and the molecules disperse, many of the water molecules on their side collide with them and bounce back instead of passing through the partition. Therefore more water penetrates the membrane in the direction of the salt solution than in the reverse direction. As the level of the salt solution rises, the extra

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force of gravity tends to force water back through the membrane. When the force of gravity and that of osmosis become equal, the difference in the levels of the two liquids is a measure of the osmotic pressure.

All living organisms, from the simplest bacterium to man himself, possess membranes that allow certain molecules to pass through and exclude others. These semipermeable membranes are responsible for many of life's vital activities. You may demonstrate these activities simply in the home laboratory.

In the egg experiment, vinegar is a satisfactory source of acetic acid. Nitric, hydrochloric, and other strong acids work more rapidly. Water molecules from the liquid begin to penetrate the membrane and dilute the food inside the egg even before the shell is completely removed.

With the aid of a microscope you may observe osmotic action of great importance in first aid and surgery. Arrange in three cups or beakers a 5-percent salt solution, another of 0.9 percent, and in the third clear water. After sterilizing a needle and one of your fingers with rubbing alcohol, make a small puncture on the side of that finger near the nail. Squeeze a small drop of blood on each of three microscope slides; then quickly dilute each drop with a single drop of liquid from a different beaker. If you have only one dropper, rinse it after using a salt solution to avoid altering the concentration.

Under the high power of a compound microscope, you will find that in clear water the red blood cells have swollen because of osmosis through the cell membrane. This is generally so rapid that the cells burst and shrivel before the liquid dries. The cells treated with the stronger salt solution shrivel without bursting because the concentration of large molecules is greater outside them than inside. But the cells in the 0.9 percent solution remain normal because concentration inside and outside are about equal.

To prevent drying of exposed tissues during an operation, surgeons bathe them in a solution of salts found in the blood. A perfect physiological solution containing traces of many elements is not ordinarily required —potassium and calcium in addition to sodium chloride make a saline solution near enough to that of blood plasma. Another medical application of this principle is the injection of a salt solution into the veins as a substitute for a blood transfusion.

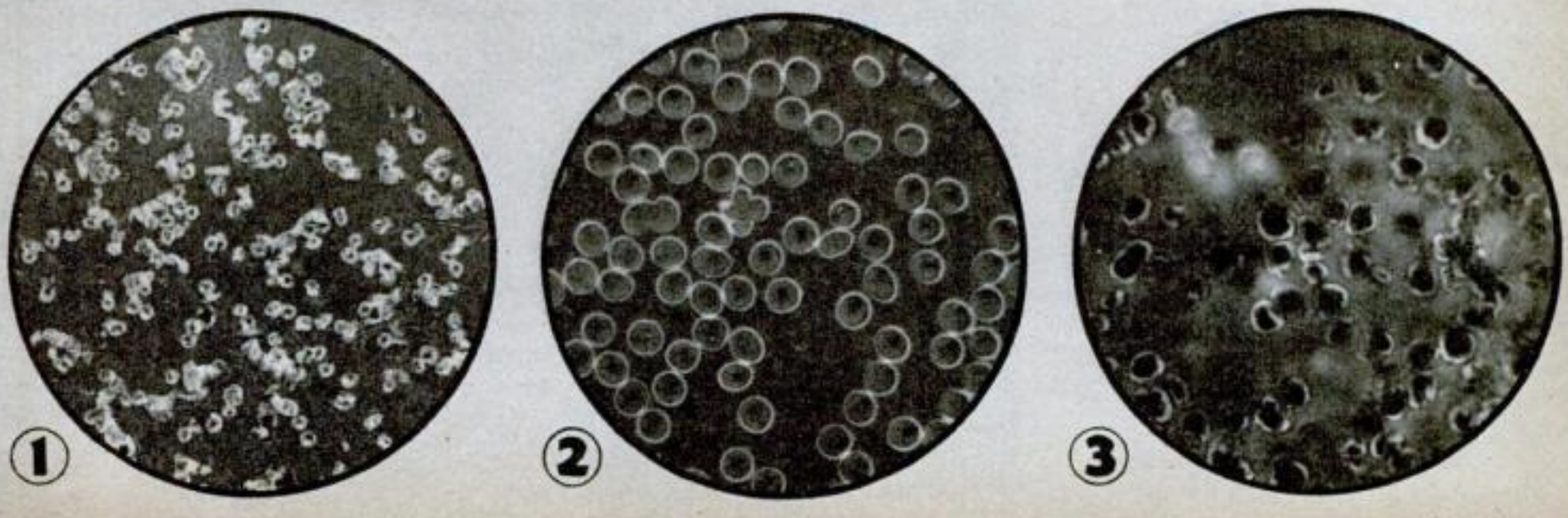
BECAUSE of osmosis, aquatic plants and animals are profoundly affected by dissolved salts. Those in the ocean, which averages about 3.3 percent salts, must be able to replace any liquids lost by osmosis from the body cells. The water of the Mississippi River at Memphis, in contrast, contains only about 0.02 percent salts, and most fish absorb more water through their gill membranes than they can use. To avoid dilution of the blood, they have a way of excreting the excess.

Nature finds novel use for osmosis in the lives of some flukes that live in the blood of man. The young have no way of leaving their tough eggs unless the eggs, escaping from the body with waste, reach water. Then they burst under osmotic pressure, releasing the young parasites. For similar action, place pollen grains from different plants in drops of water under the microscope.

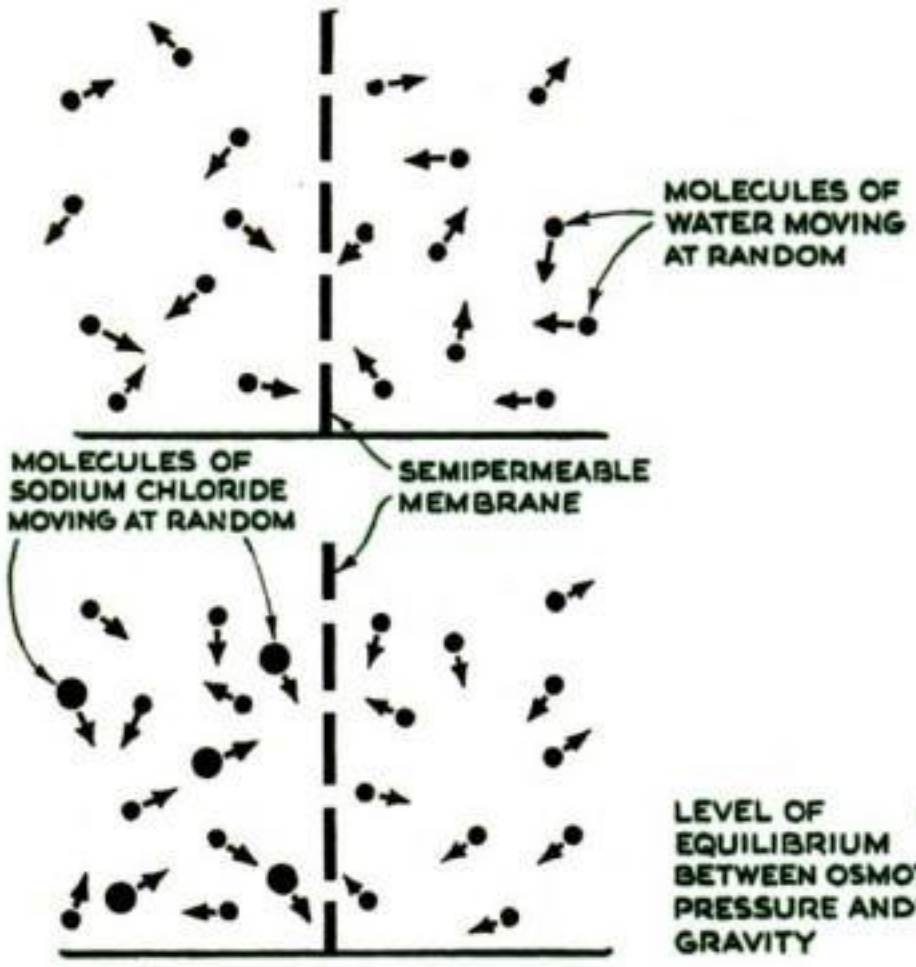
To visualize the importance of osmosis to plants, hollow a section of carrot or turnip root to form a cup. Pour a strong salt or sugar solution into it and set the root in a shallow dish of water. The level inside the

PHOTOMICROGRAPHS SHOW HOW OSMOSIS AFFECTS BLOOD CELLS

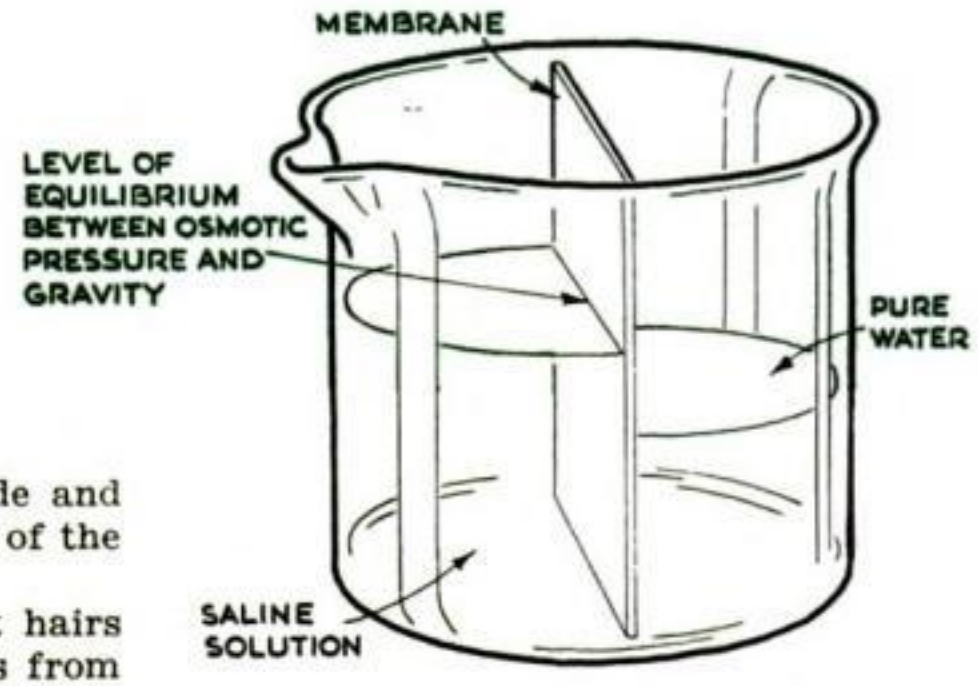
Human blood cells will shrivel, remain normal, or explode, depending on the salinity of a solution in which they are immersed. Osmosis accounts for this difference in behavior. In Fig. 1 the cells have been immersed in strong brine and they have shriveled as water molecules escape outward from the membrane that covers each cell. In Fig. 2 the cells, being in a 0.9-percent salt solution, stay unchanged. Put in tap water (Fig. 3), they quickly burst open as an osmotic pressure builds up inside



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SALT SOLUTION on one side of a thin membrane dividing a beaker will rise higher than clear water on the other side. Both salt and water molecules are in constant motion, and an equal number of particles on each side hits any given area of the membrane, but only the water molecules, being smaller, can go through the tiny pores. More water molecules hit on the clear side, and therefore the saline side gains more water molecules than it loses. Action of gravity forces some excess water back, and the difference in levels is called osmotic pressure



"cup" rises until it runs over the side and gradually equalizes the concentration of the two solutions.

By this same absorption, tiny root hairs take up water and dissolved minerals from soil. Because the cell sap within the roots is more concentrated than that in the soil, an osmotic pressure is exerted inward; and with the aid of capillary action through fine transportation tubes, liquids rise through the stems to the leaves. Laboratory tests show that the concentrated sap of various desert plants may exert a pressure up to 3,000 lb. per square inch.

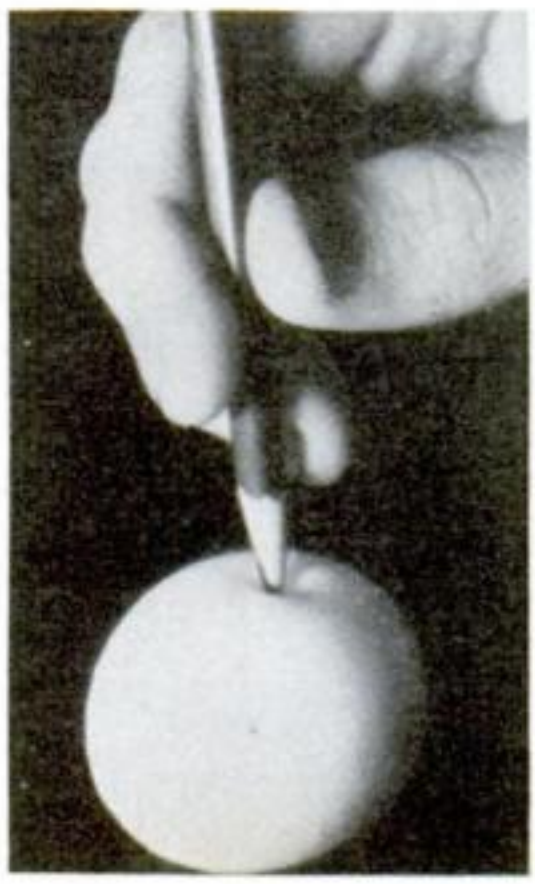
Victory gardeners who apply too much highly soluble commercial fertilizer to new tomato plants reverse the process. Pour a weak salt solution into the hollow carrot and place it in strong brine. Pressure is then exerted outward, and liquid leaves the root. That is why plants may be starved by overabundance of food.

Chemists are synthesizing membranes in hope of improving on nature. A very fragile membrane may be produced by making a solution of copper sulphate and dropping into it a small piece of potassium ferrocyanide. (Both chemicals are internal *poisons* and *must be handled carefully.* The ferrocyanide appears to grow, branching irregularly, because of absorption through a semipermeable membrane synthesized around its surface by a reaction with the copper sulphate.

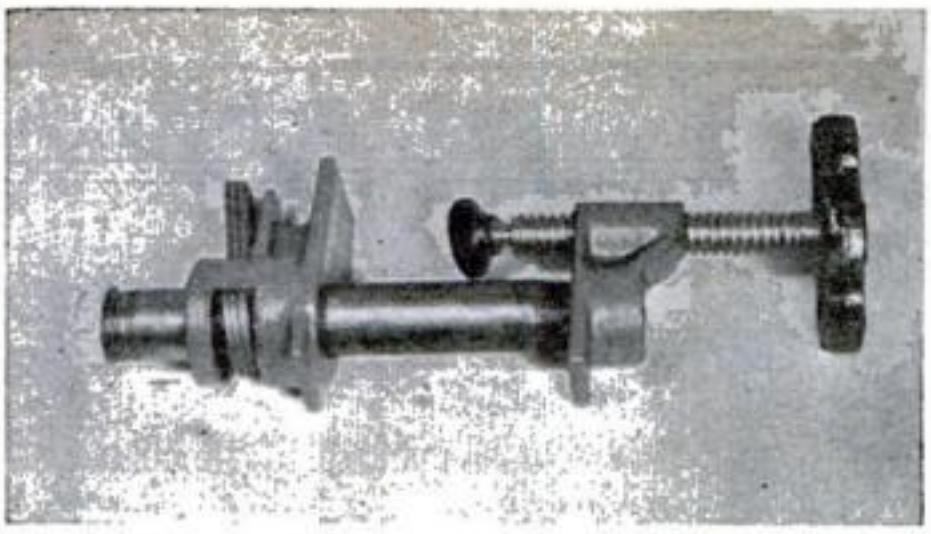
One of the persistent mysteries of osmosis has been the ability of membranes to "select" the kind as well as the size of particles they allow to pass. Two plants may grow side by side yet take different minerals from the soil. The walls of man's capillaries allow food particles to pass out into the tissues and waste particles to enter the blood stream, while other particles of similar size are excluded.

This may be due to the presence of electrical charges known to be on many membranes. In solution certain molecules break down into positive and negative ions, such as the positive sodium and negative chlorine ions of salt molecules. A red corpuscle "selects" the chlorine ions and repels the positive sodium ions.

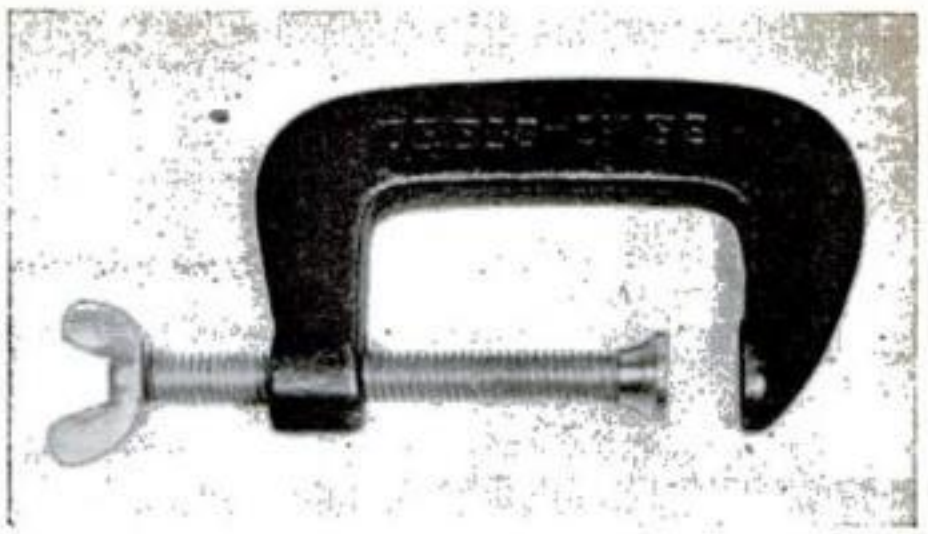
ITS SHELL DISSOLVED by acetic acid, a membrane-covered egg will swell if placed in a cup of water. Osmosis lets water enter; it keeps food in



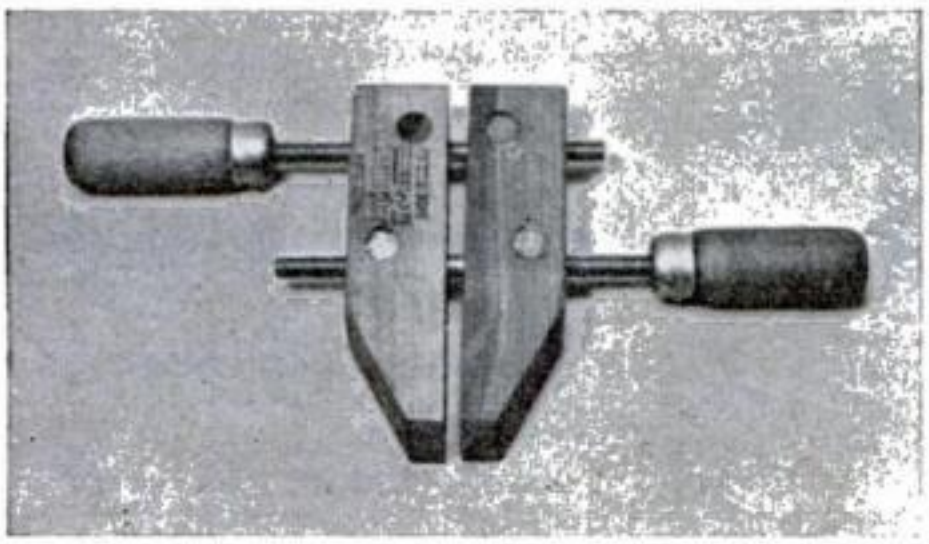
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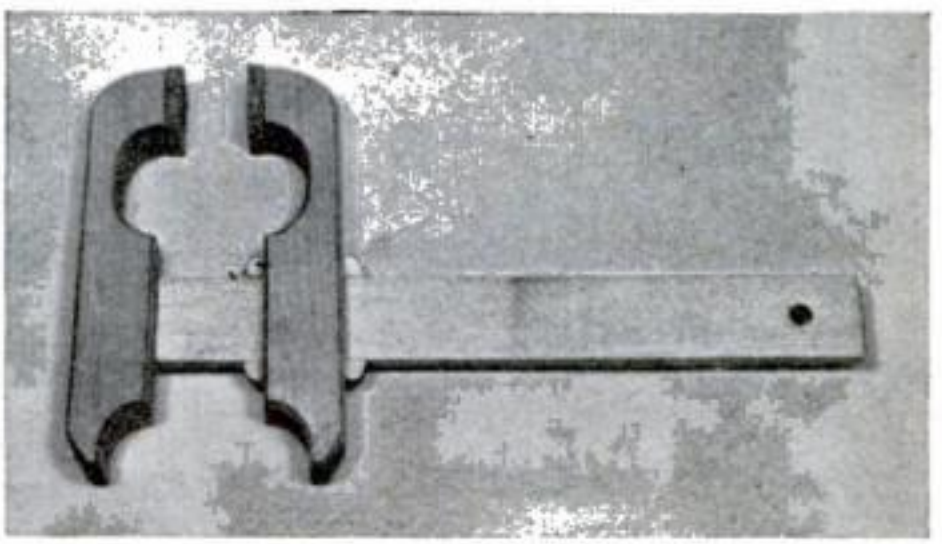
1 .....



2 .....



3 .....



4 .....



Question Bee

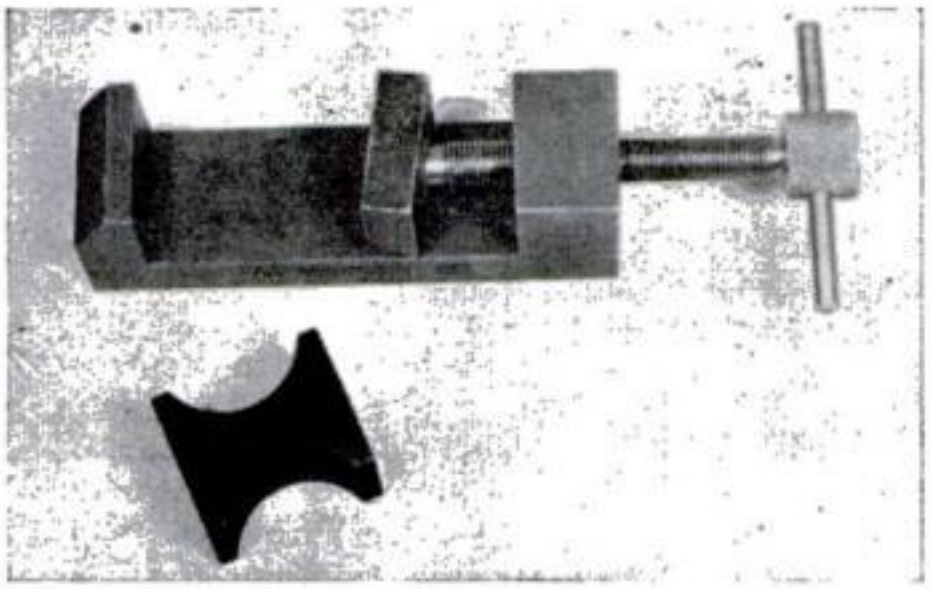
SOME forms of clamps and vises will be found in every shop where wood or metal working is done. On this page are photographs of eight that are in common use for a variety of jobs. Can you name them? Write your answer for each in the space provided under its photo; then turn the page upside down to check your accuracy.



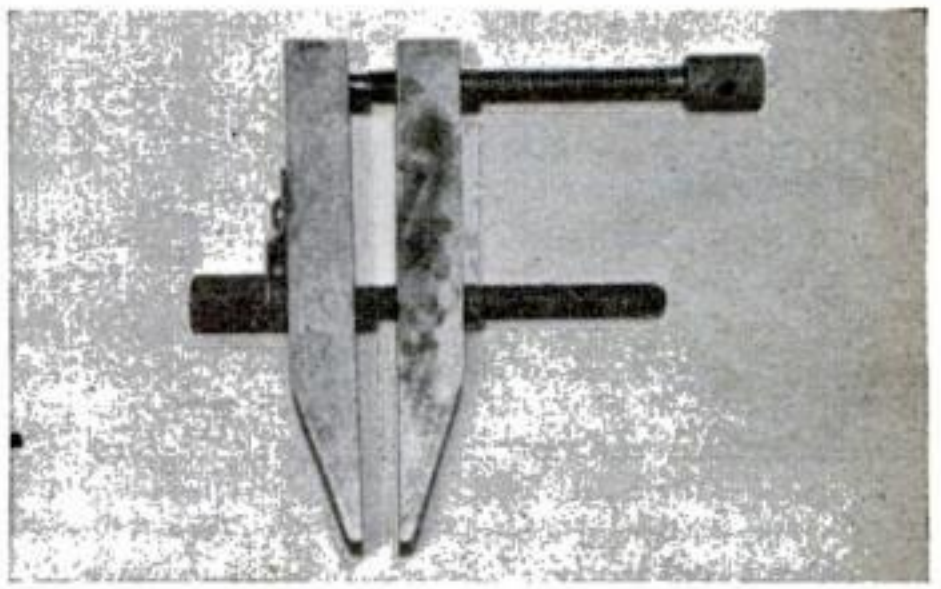
ANSWERS

1. Cabinetmaker's bar clamp.
2. C-clamp.
3. Hand screw.
4. Screwless bar clamp.
5. Saw vise.
6. Clamp-on machinist's vise.
7. Toolmaker's vise.
8. Toolmaker's parallel clamp.

5 .....



6 .....



7 .....

8 .....

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Will a Converted



A thoroughgoing conversion, this tractor is practically the equal of a factory-built job. Sprocket and shaft must be guarded in use

Pros and Cons on the Value to a Farmer of the "Doodlebug," Plus Pointers on Remaking Old Autos and Trucks for Use on Our Farms

FARM tractors built by converting autos or trucks may not be able to do *all* the jobs on *every* farm, but if properly modified and used within their limitations, they do have a definite place on many U. S. farms today. That's the verdict of ingenious farmers who have been confronted by both the scarcity and high cost of used as well as new farm equipment, and who have accordingly followed the tradition of building what you can't buy.

Don't make the mistake, though, of taking the worn-out family car, hacksawing its body off, and then expecting the result to be a satisfactory "doodlebug." Experienced farm mechanics warn that this approach just won't do. They say that the work which can be obtained from such a conversion is in direct proportion to the amount of converting done, and that for a satisfactory job, attention must be given to the cooling system, motor, transmission, and rear end.

Typical of the better conversions is the general-utility tractor made by H. J. Schultz, of Champaign County, Ill., and pictured on this and the facing page. Its principal features include ample cooling capacity, short turning radius, high road speed, ability to exert a strong drawbar pull at speeds as low as 1½ m.p.h., and suitability for general belt work as well as for field work requiring both draft and belt power.

Mr. Schultz used a 1929 Chevrolet chassis in building his tractor. A secondhand tractor radiator was mounted in place of the original radiator, and the manifold was turned end for end to permit substitution of a downdraft carburetor for the standard one. To simplify operation under conditions where the load varies frequently, a governor was also installed.

The frame was shortened by cutting off the longitudinal members just forward of where the rear wheels originally were. After an end beam was added, the frame was mounted directly on the axle, without any springs. In shortening the drive shaft, enough space was left for a second transmission and a second universal joint, located directly behind the first. The use of two transmissions between motor and differential gives the tractor seven forward and three reverse speeds.

The lowest forward speed of the tractor, about 1½ m.p.h., is obtained by putting both transmissions in reverse. Second speed, only slightly higher, is secured by putting both in low. Third speed is achieved by having the front in second and the rear in low, or vice versa. Fourth is obtained by having one in high and one in low; fifth by having both in second; sixth by having one in high and one in second; and seventh by having both in high. There are three different reverse speeds, obtained by having one transmission in reverse and the other in low, second, or high.

On the forward end of the second transmission a 5½" sprocket was placed to drive the power take-off. A roller chain connects this with a 16" sprocket mounted on a third transmission, located on a platform just to the right of the driver's seat. This transmission is reversed in position—that is, turned end for end—so as to speed up the power take-off shaft. One end of this shaft is supported by the transmission and the other by a 3" babbitt bearing. The shaft carries both

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Auto Do Tractor Duty?

a belt pulley and a sleeve, fastened with a stud, which makes it possible to use either a standard square or splined stub shaft to connect with the equipment to be powered. Though photographed for clarity without guards, the chain drive and shaft stud must be protected by shields for safe operation.

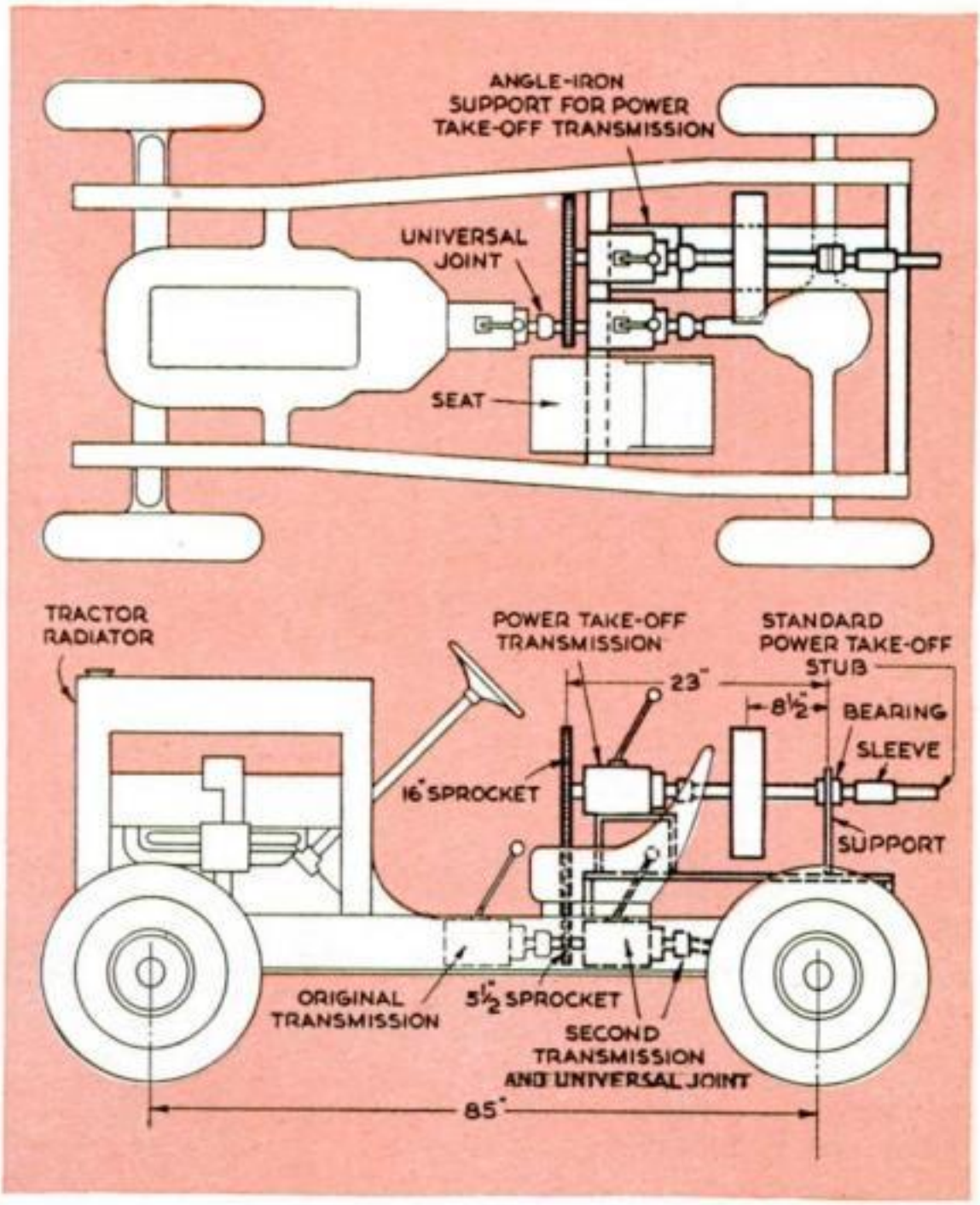
On the highway, the tractor can pull a rubber-tired farm wagon at regular highway speeds, except perhaps on rough roads where the absence of rear-wheel springing brings some slight limitation of speed. With both driving transmissions in reverse, it can readily tackle field jobs requiring substantial drawbar power. For example, it has sufficient power to pull an 85-bushel load of corn, and it has pulled a 10′ combine in the field.

The belt pulley on the power take-off shaft makes the machine suited for stationary work requiring belt power. Many farms move around a stationary engine to handle such jobs as grinding feed, operating an elevator, or sawing wood; and the fact that the utility tractor can move to such jobs under its own power often means a saving of time and effort. Tasks requiring both belt and draft power may also be handled with dispatch, as when a load of corn is hauled in, the wagon dumped, and the corn then elevated to the crib.

The speeds of the auxiliary shaft are particularly suited for mowing. For example, a standard power mower may be quickly hooked on by dropping a pin through two holes drilled in the rear cross frame of the tractor and connected to the mower drive-shaft. With this rig, a heavy growth of hay can be cut at a speed of 7 m.p.h.; and as conditions warrant it the speed of the sickle may be easily varied by changing gears in the take-off transmission. A standard post-hole digger may also be attached, and with it two men can dig post holes at the rate of one a minute. The higher speeds that the tractor can achieve when pulling a rotary hoe also adapt it to killing weeds. [*Turn the page.*]



Enough drawbar pull to handle heavy loads is delivered through a second transmission and universal joint mounted back of the first



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Following plans that were supplied by the maker, Jack Fronk of Tremonton, Utah, did this conversion of a Chevrolet truck. The wheel base was cut to about 108". The rear end and differential housing were coupled to the transmission without a propeller-shaft housing. Heavy pulling such as plowing is done with the use of compound low gear. Note the double wheels in back

When regular farm machinery was easier to get, many farmers looked with disfavor on such conversions. The commonest criticisms, as well as the rebuttals now often mentioned, are these:

They need a good deal of space to turn around in. While this characteristic holds true to some extent for many conversions, a substantially shortened wheel base means a reduced turning radius.

The distance between the wheels on one axle is usually too great. It is true that this often offers difficulties in operating two-row machines such as seeders, corn planters, potato planters, and so forth. Unless the person making the conversion has an unusual amount of skill, little can be done about it.

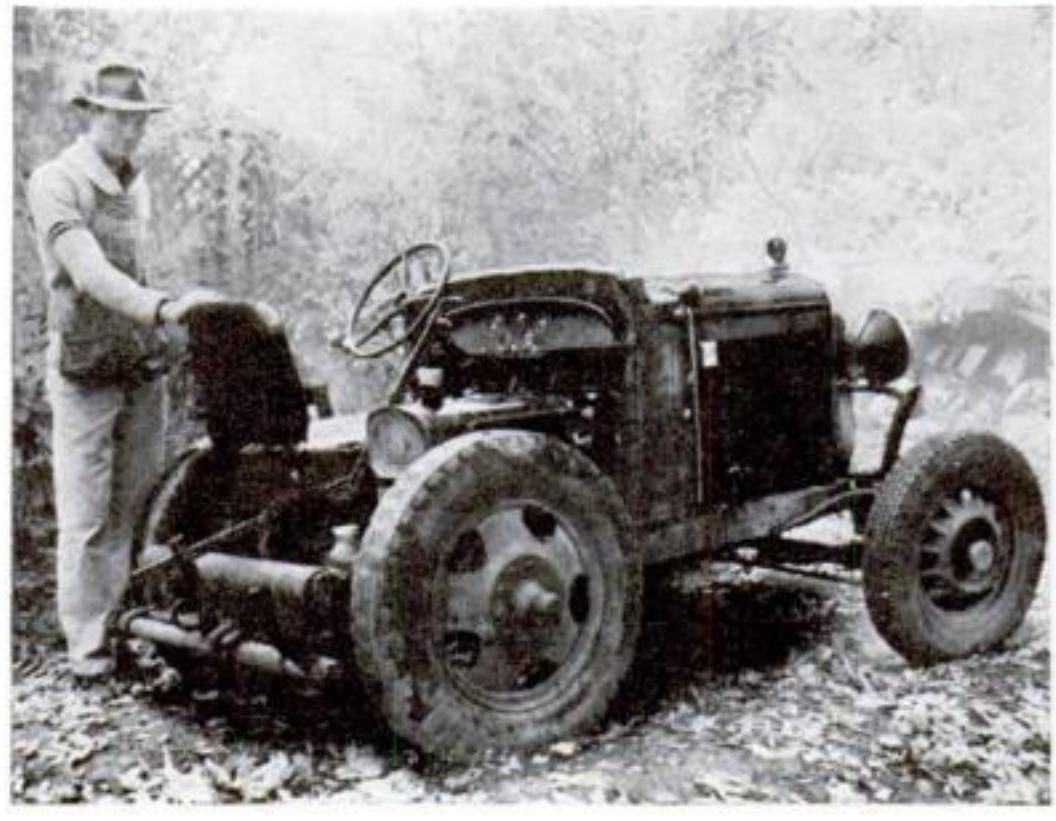
Clearance is often insufficient. These tractors are almost always suitable for cultivating crops like beets, carrots, and onions. Moreover, the actual clearance achieved depends on inherent clearance of the chassis, often a matter of its age, and on the wheels and tires used. The Schultz tractor previously described has successfully operated a weeder in a field of corn from 18" to 24" high.

In heavy work, the homemade tractor is prone to wheel slippage or to overheating. Whether or not this is a valid criticism depends on the skill exercised in conversion. With extra cooling capacity, plus an additional transmission fitted with an extra universal joint, torque delivered at the rear axle should be sufficient. The actual traction secured depends of course on the loading of the rear wheels and on the tires used.



A 1931 Dodge truck, transmission, and differential constituted the basic material used by Jerry Larkin, of Brigham, Utah, in producing the "doodlebug" shown above. A 500-lb. weight over the rear axle, chains on the back wheels, and only 15 lb. of tire pressure aid in plowing. Here a saw is being powered

The lever to the right of the driver's seat in this homemade tractor permits the operator to raise a spring-toothed harrow at will. A heavy steel shaft, visible just above the hitch, serves to increase the traction of the rear wheels. Chiefly used for disking and harrowing, the tractor has worked well



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Ships That Won't Stay Sunk *(Continued from page 124)*

feet of rock separates the ceiling from any area upon which a Jap bomb could land. Right through air raids, the work has gone on with improvised machine tools, ingenious substitutions, and age-old skill.

When Mingsung undertakes a job, the calendar is a big factor, for by June of each year every vessel in the shipyard must be ready to float. Early that month, the Yangtze River rises as much as 90 feet. If a ship is not seaworthy, it sinks right in the shipyard. The machine shops in their dugout, as well as exposed buildings of the plant, are well above the high-water mark, but ships cannot be shelved until the water recedes.

The story of Mingsung started with the Japanese advance. First, the personnel was evacuated from a Shanghai shipyard. The company bought ships and hastily manned them, bringing them up the Yangtze. Some were bombed, some sank in the treacherous rapids, but most of them arrived at Chungking.

The ships were invariably oil-burners and had to be converted. One of Mingsung's continuing jobs has been to install coal-burning boilers. This is not a mere tinkering process. The ship—whether it be wood or steel—must be sliced in two, lengthened up to 15 feet, and the new boiler installed. One ship now in the yard had been cut in two, lengthened, and patched partially when the water suddenly rose and inundated the yard. The two ends of the vessel floated, but the newly patched middle buckled. The workers are taking out the rock and mud and are ready to start over.

That would be fairly simple if materials were plentiful, but Fountain C. Y. Chen, assistant manager of the yard, who was trained at Union College in Schenectady, N. Y., and studied under Steinmetz, pointed to a sheet of steel plate and said sadly, "This is the last plate of steel that came over the Burma Road."

Everywhere in the plant, the 2,000 employees resort to amazing modes of operation. From a new machine tool they have created other machine tools. From salvaged parts of engines, they have built power hammers and other heavy machinery. The divers have gone down from 50 to 60 feet to raise ships or parts of ships for use in any one of hundreds of spots.

That takes trained personnel, and the shipyard has among its employees 200 apprentices whom it has chosen from junior high schools by competitive examinations. These boys, working with veterans of the Shanghai shipyard, soon learn to build an engine from virtual scrap, to repair a bombed generator, to construct a complete steel rolling mill.

Everyone at the shipyard works from 6:30 in the morning until 6:30 every night, with an hour off for lunch at 11:30. Although their hours are long, they work hard every day with the exception of two days a month. These days coincide with paydays, so the men are able to enjoy what little leisure is available. They live and work on the grounds. Their quarters, mess halls, and recreation facilities have been built by the yard. Right through the Jap bombings, they work on. Fragments of bombs four feet square, as well as several unexploded bombs, are on display in the offices. The men smilingly call it their museum.

They overhaul and repair an average of 22 ships a month, while three new ones are under construction at the same time. Just launched are 10 "wooden Liberty ships," vessels that look like small excursion boats. They are 200-ton ships for river, passenger, and freight traffic. A launching is entirely without trappings—no champagne, no brass band. The officials climb aboard. There is steam in the boiler. A channel is dug to let the river water enter the basin. The ship's captain rings the engine-room bell, and the vessel launches itself, steaming out into the treacherous current of the Yangtze for a trial run. The shipyard officials go along, both to check the equipment and to express their complete faith in the work of their men.

The plant is continually running out of material. With some 5,000 items in their day-by-day stock room, many a substitute has to be improvised. Engine parts have to be fabricated. Even the small glass boiler gauges have been blown in Chungking.

"The war has forced us to learn many techniques and even invent new ones," said Chief Engineer Chi F. Yeh, who was trained at the Massachusetts Institute of Technology.

A dozen ships are in the yard now. Parts machined in the dugout are pulled down the beach and placed in them. Then floating machine shops on barges come alongside to make final adjustments. The ships may not be beautiful, but they go. They can carry supplies down-river in five hours on a trip that would take five days overland. Not content with these, Mingsung has planned a luxury liner to be "queen of the Yangtze."

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Weapons Are His Hobby

(Continued from page 61)

him put his collection on exhibition there. In the years between 1931 and 1939 nearly ten million people paid cash on the line to visit "Jarrett's Museum of World War History." The revenue gave him new resources. Soon he had agents all over the world hunting for choice items of ordnance.

Hollywood sought the services of a man who was an expert on all the trappings of war. Jarrett dug up paraphernalia for "The Charge of the Light Brigade" and many other celluloid epics. But Hollywood did more for Jarrett than borrow his show pieces and use his technical help. Out on the Hollywood lots lay many a relic of the World War, used for some battle scene and then abandoned. Jarrett traded the Hollywood prop men out of their eyeteeth and carried to Atlantic City many a rare piece.

At its height, Jarrett's museum totaled more than 70 tons of war equipment. In addition to ordnance there were thousands of photographs, hundreds of posters, a reference library of more than 600 volumes. For Jarrett was not merely a collector. He was a serious student of ordnance. Back of the cow barns at Workman's Dairy Farm near Moorestown, N. J., he set up a firing and testing range.

Jarrett had been a reserve officer since 1926. He went on active duty in November 1939. In February 1942 he joined General Montgomery's harassed army in Egypt. He was one of our technical advisers to the British Eighth Army, showing them the ins and outs of the American lend-lease tanks and guns that were beginning to trickle into Egypt around the Cape and up the Red Sea. But his first sight of a smoking battleground kindled the hot spark of the collector in him. As the Battle of the Desert surged back and forth, Jarrett dashed hither and yon in a jeep, snatching enemy ordnance.

His enthusiasm infected others, and soon there was an informal ordnance team collecting from Cairo nearly to Benghazi. Indifferent to bullets, they rode into the heat of battle to take movies of tanks and guns in action.

In the basement of a rented building in Cairo the pile of "Jarrett's junk" grew until it reached the roof. Jarrett didn't mind risking his own neck, but the front was too close to his treasure trove for comfort. Civilians were evacuating Cairo. In September a cable went to General Barnes. Jarrett had a collection that would immeasurably help our own war effort. What should he do with it?

Barnes was quick to act. Jarrett got orders to begin shipping the stuff at once. That was the beginning of FMB. But in those days U-boats were still swarming around the Cape and in the South Atlantic. Several tons of Jarrett's treasure went to the bottom in ships that were torpedoed.

In its huge building at Aberdeen, FMB has in less than a year and a half built a collection of 1,200 specimens of Axis ordnance equipment—nearly 600,000 separate items! They range from a fragment smaller than the palm of your hand to a 60-ton German Panzer VI tank and an eight-inch German heavy field howitzer. Up to 3,000 visitors in uniform—trainees from Edgewood Arsenal, Fort George G. Meade, Fort Belvoir, and other training centers—troop through the museum each week.

The collection reflects both the strength and weaknesses of Jap and German field units. The Germans, Jarrett may point out, were using brass cartridge cases when the war began. As they began to feel the pinch of shortages, they switched to brass-plated steel cases. Next they cut out the brass altogether and blued the steel cases to protect them against rusting. But as a tribute to our constant hammering of Hitler's industrial centers, the latest shell cases are turned out without any protective coating.

Firing and testing enemy weapons at Aberdeen discloses many things that help our commanders in the field. For example, tests showed that the latest Japanese .303 caliber rifle is inaccurate beyond 350 yards, while our Garand can hit the bullseye at a far greater distance. Because its magazine holds only 30 rounds, the Japanese light machine gun can be fired at a rate of only 200 to 300 rounds per minute, whereas our .30 caliber Browning can fire double that number. Yet, though it is clear Japan does not belong in the big league where ordnance is concerned, and though Germany is feeling the pinch of inferior workmanship and shortages of materials, Aberdeen experts warn against underrating the Germans.

At the outset of the war, German engineers had achieved a tremendous advantage by reducing the number of parts in their weapons. This speeded production and saved Hitler the necessity of maintaining large numbers of technical troops for maintenance and repair work. Hitler's production system is still a formidable enemy. FMB and the ordnance department are still working overtime to keep our own war industry on its toes.

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Remember when . . .

you could say: "Fill 'er up"... and get it?

THAT was when Sunday Driving was the Great American Sport, and automobile vacation trips were a "must" for most of us.

Then, tires were valued in dollars—now their worth is measured in *lives*. For the Battle of Rubber is *not yet won*—driving too much, too fast and too carelessly is *still* just like shooting an American soldier in the back. Every ounce of rubber in every tire on every car in America is *still* a war weapon!

Contrary to popular opinion, satisfactory synthetic tires *are not yet available* in sufficient numbers to satisfy both military and civilian needs. No one knows *when* you will be able to replace your present tires.

Those you have *must* last—and *will* last if you observe these simple precautions: Start and stop slowly. Go easy on curves. Don't bang into curbs, ruts and stones. Keep air pressure up to 32 pounds. *And keep your speedometer down to 35!*

By *lengthening* the life of your tires, you may *save* the life of a fighting man!

★ ★ ★

REMEMBER WHEN you found the left rear tire flat that Sunday morning? Who was it who came over and changed it in time for you to get to church? Chances are it was your INDEPENDENT tire dealer who has a real interest in pleasing you because he owns his own business. *Seiberling believes in the initiative of INDEPENDENT business that has always made good jobs and good opportunities plentiful in America. That is why Seiberling Tires always have been and will continue to be sold through INDEPENDENT dealers only.*

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WRIGHT POWERS THE TONNAGE OF THE AIR

vest pocket power



Why put an air-cooled aircraft engine in a tank? Because no other engine packs as much power into such small size. Tanks and gun carriers slog into battle on caterpillar treads, but they are similar to aircraft in that they require an engine high in power, small in size, and light in weight. Other engines of equal power are massive, creating a vicious circle in which large size demands more armor plate, in turn adding weight and calling for more power to maintain speed.

Seasoned by years of operation in transport, private, and trainer planes, the Wright Whirlwind was the logical choice for the Army's medium tanks and gun carriers. This engine, weighing but a scant 1% of the M-4 tank's 30 tons, packs 400 HP plus in its 45" diameter.

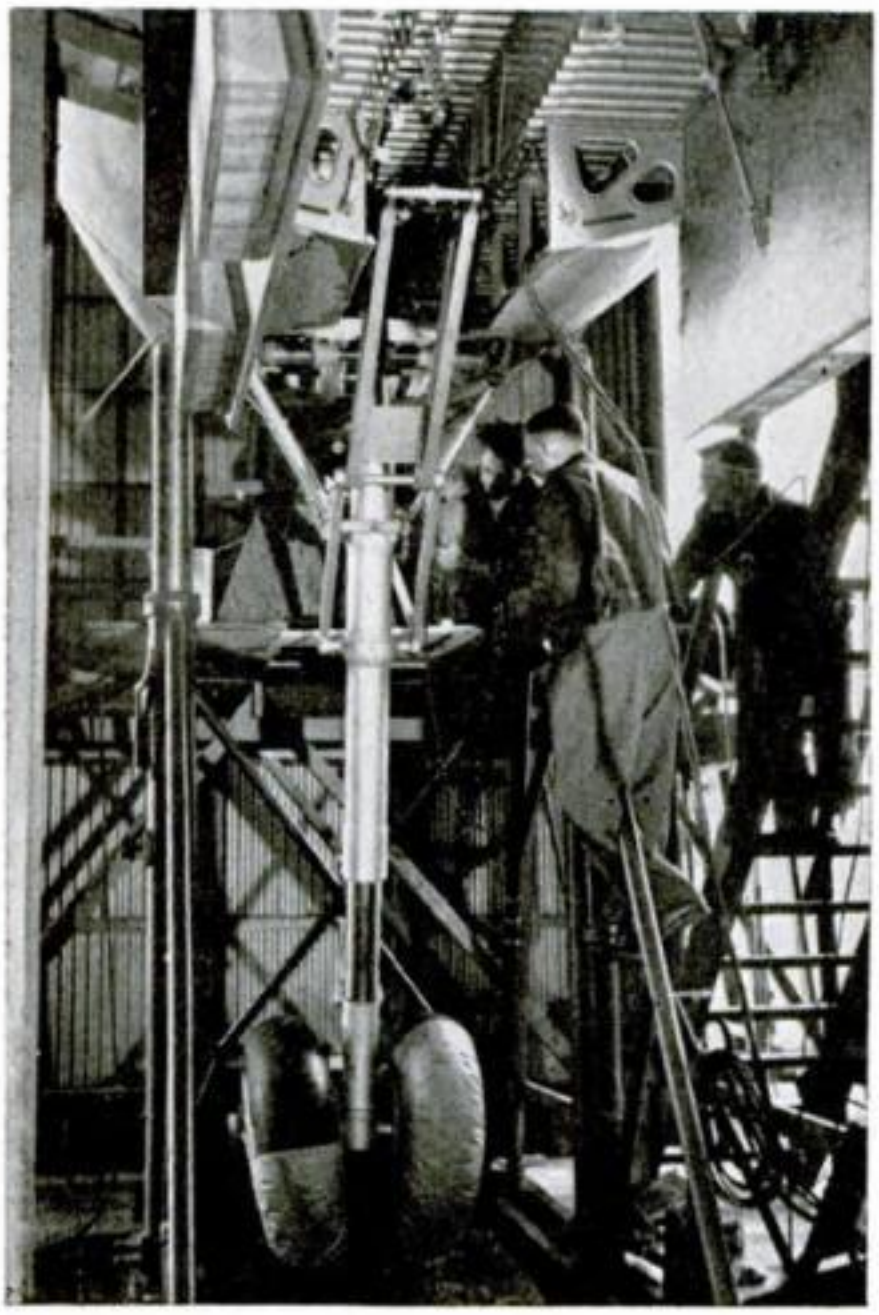
Enlisted in our armored divisions, the Whirlwind was assigned to combat duty with virtually all medium tanks and heavy gun carriers to reach the fighting fronts. In no sense a competitor to the air tonnage hauling Cyclone, the Whirlwind has nonetheless lived up to the Wright tradition for light, compact power, adaptable to many purposes.

Cyclones and Whirlwinds · Light · Compact · Powerful **WRIGHT** *Aircraft Engines*

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Landing Planes Safely

(Continued from page 80)



The giant nose-wheel unit of the Lockheed Constellation, shown here being tested, has double wheels dished in to prevent wobble in landings. It has two-wheel brakes and is steerable from the cockpit

their drawbacks. They usually weighed so much that the horsepower required to lift them was often more than that originally required to overcome the drag of the gear without them.

Modern design, with the help of light metals, has produced some really satisfactory "pants" for certain types of aircraft in which retracting gear is impractical.

In 1917, the name of Capt. James V. Martin first became prominent in connection with landing gear, when he developed a unique semiretracting gear for his little KIII Scout biplane, built at Elyria, Ohio. This rigid-strut gear had wheels with flat springs for spokes, which acted as shock absorbers. By means of a crank, the landing gear could be fully extended or almost completely retracted into wells along the side of the fuselage.

The following year, Captain Martin brought out another innovation. On an old De Havilland biplane he worked out the first split-axle landing gear, doing away with the spreader bar, which had long been a hazard on rough fields and in tall grass.

Also in 1920 there appeared the first really retractable landing gear. A Martin design, this was fitted to the Dayton-Wright Gordon Bennett racer for the Army Air Corps. By means of a nut working on a threaded shaft, and a bicycle chain, the pilot cranked the wheels up and down by hand. This ship was the forerunner of such planes as the Grumman FF-1, delivered in 1931, the first military aircraft equipped with retracting gear.

Boeing pioneered in hydraulic landing gear for big stuff in 1930, fitting it to one of their Monomail models. To test its efficiency, they raced it against another Monomail, which had fixed gear with the best "pants" then available. The Monomail with gear retracted left the sister ship far behind, with a speed difference of 15 miles an hour. Retracting gear for big aircraft was here to stay.

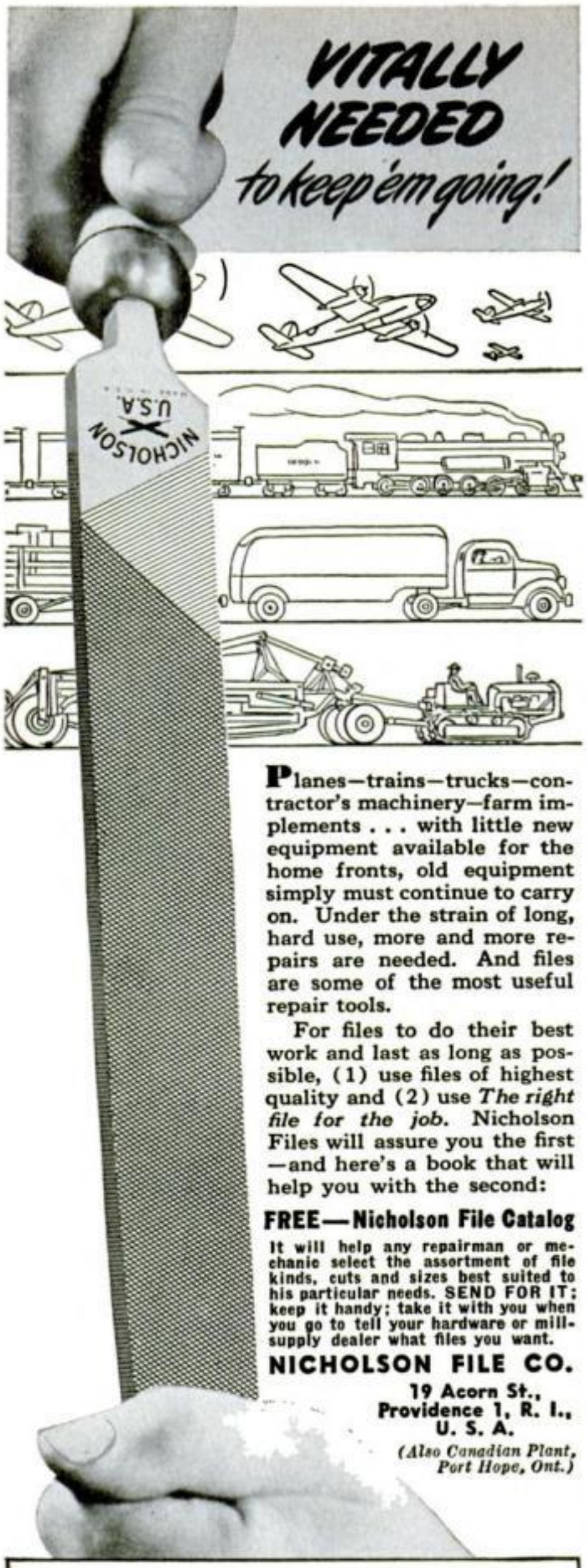
Modern retracting gear is all basically the same, although the means and manner of operation vary. Some fighter planes, such as the Spitfire and the Messerschmitt 109F, retract the wheels outwardly toward the wing tips. The Focke-Wulf 190A and the Zero fold theirs inwardly, as do several American planes. Certain other American ships, including the Grumman Hellcat and the Curtiss P-40, fold their "legs" straight back while the wheels themselves rotate 90 degrees to lie flat in the underside of the wings. It's all a matter of the best method for the particular type of ship.

In the big bombers, it has been found most convenient to retract the gear into the rear of the engine nacelles. In some cases, the wheels are only partly enclosed, while in others they are entirely buried within the ship. Some of the newest big ships include flaps that cover the fuselage openings where the wheels lie when retracted, even when the wheels are down. Sealing the jagged openings has in some cases reduced the take-off run as much as 15 percent and boosted the initial climb greatly. These flaps also serve to protect the interior of the wheel wells from dirt, mud, and rain.

The pilot, of course, must know the exact position of his gear at all times. To provide for this, designers have worked out various devices for the instrument board. Some visual indicators have a small plane on the dial, whose wheels exactly follow the posi-

(Continued on page 204)

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Planes—trains—trucks—contractor's machinery—farm implements . . . with little new equipment available for the home fronts, old equipment simply must continue to carry on. Under the strain of long, hard use, more and more repairs are needed. And files are some of the most useful repair tools.

For files to do their best work and last as long as possible, (1) use files of highest quality and (2) use *The right file for the job.* Nicholson Files will assure you the first—and here's a book that will help you with the second:

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Landing Planes Safely

(Continued from page 203)

tions assumed by the wheels of the actual craft; a light flashes on when the wheels are down and locked in landing position.

Audible warning systems use a horn, connected with the throttle, which blasts in the pilot's ear if he closes the throttle coming in for a landing with his wheels still up.

Getting the wheels up and down safely is but one side of the problem; there are still many details to confront the gear designer. For example, he must consider propeller ground clearance when the gear is fully compressed under top impact loads. There must be at least nine inches clearance for the whirling blades at all times, regardless of the landing or runway surface.

Modern Aerol-type shock absorbers seem to be the perfect solution for all problems encountered to date. This unit consists of a combination air-oil, shock-absorbing strut, which forms the main leg of the gear itself. One portion of the leg telescopes within the other to form a piston which forces air and oil into a chamber within the leg. The compression qualities of these two substances absorb the shock and, with the aid of linkage devices and valves, control the rebound of the gear to assure smooth, safe landings.

Problems met in designing landing gear for helicopters and autogiros include the consideration of vertical as well as oblique impact loads. Designers of ski landing gear have their own particular problems.

The landing gear of seaplanes (not flying boats) is usually one of two types. One consists of a center float under the fuselage, augmented by small floats on the wing tips for rough-water landings. In the other, there are two floats under the fuselage and no wing floats. The latter type is seldom used on military combat craft but has been successful on planes ranging from small private craft to ships the size of the Douglas DC-3 airliner.

What the future holds in the way of new landing-gear types is problematical; but with rocket planes and superhigh-speed, jet-propelled aircraft in prospect, it may be that the problems of the gear designers have just begun.

Correction

OWING to the misplacing of a photo credit on page 121 of our April issue, the impression was given that Demerol, the new synthetic analgesic, is a product of Parke, Davis, and Company. Demerol is made by the Winthrop Chemical Company.

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Chrysler Searchlight Reflectors and Bofors guns are used together on our battleships for night fighting.

"Nelly" was a tough gun to make . . . she used to require so much handwork that only a few could be produced in a year. Today, certain of her precision parts are finished by a revolutionary process called Superfinish . . . the same process that gives Chrysler engines the smoothest moving parts in history. Thanks to Superfinish and to the employment of other automotive methods, the production of parts for Bofors guns has been speeded incredibly since Pearl Harbor.

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BACK THE ATTACK—BUY WAR BONDS. Defoe workers take more than 10% of their pay in War Bonds



The Toughest Man in the World to Please

THE "hard-to-please" attitude of the Defoe shipbuilder is not a war measure. It's a life-long Defoe tradition. Harry J. Defoe—who founded the yard nearly forty years ago—and his crew are old hands at building sea-going vessels. They know that even peace-time ships that go down to sea must be built to withstand battering that no land-bound structure receives.

Today this experience is paying extra dividends to the Navy in the form of sound construction, added protection for crews, and lower manufacturing costs. The fleet built for the Navy in the Defoe yards since Pearl Harbor numbers more than 65 fighting ships. And now a squadron of LCI (L) Landing Barges is taking form on the production line. These ocean-going invasion vessels are the spearhead of America's growing offensive. In making them, we pledge your sons all our skill and experience, all the Defoe tradition of safe, sound, deep-sea shipbuilding.

When Peace returns, Defoe's advanced manufacturing technique and skilled craftsmanship will provide quality products of greater value and lower cost for all Americans to enjoy.

DEFOE SHIPBUILDING COMPANY, BAY CITY, MICHIGAN

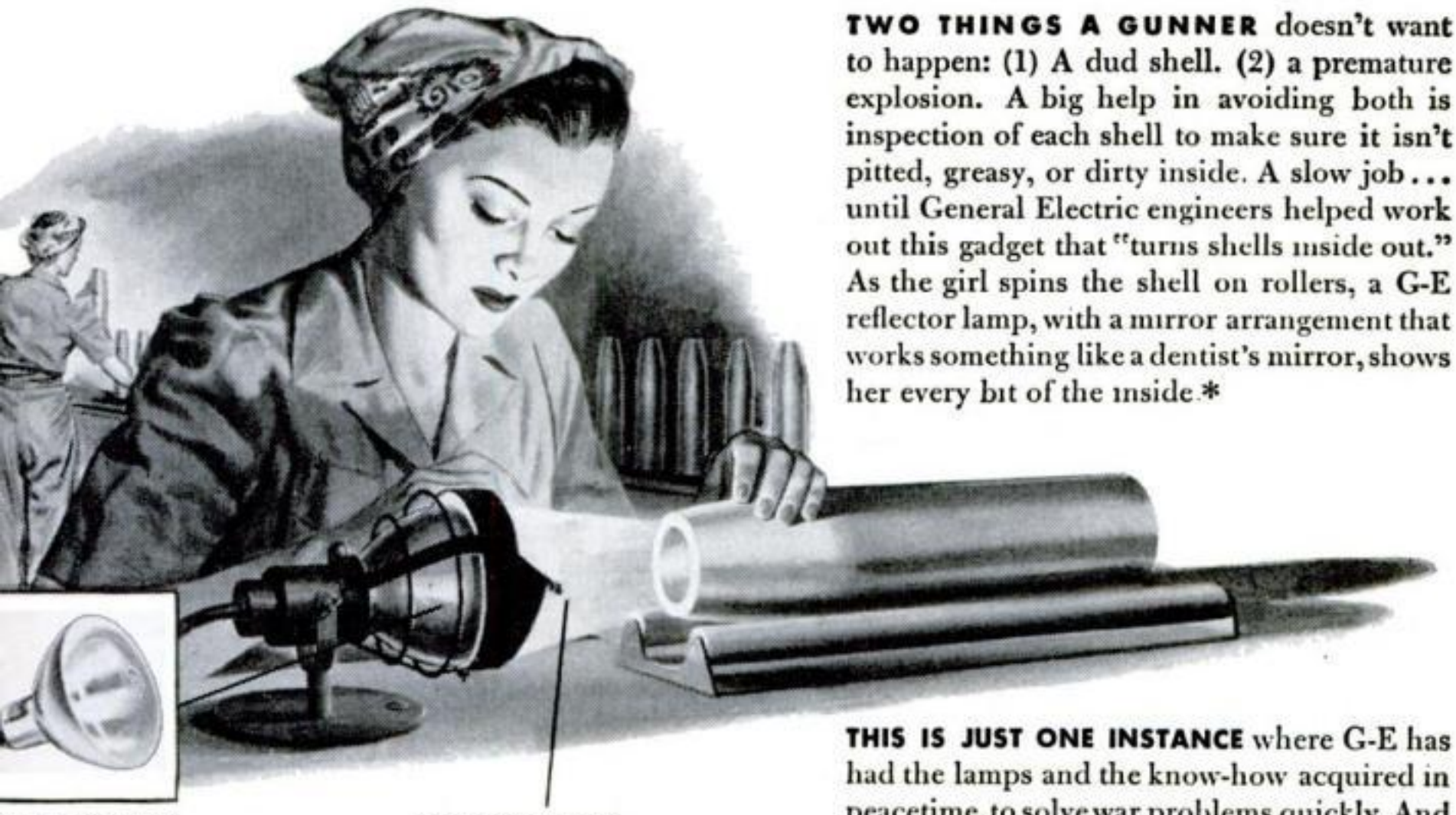
Three White Star Renewal Citations now decorate the Navy "E" Award won by Defoe workers.

SHIPS FOR VICTORY — Defoe — SERVANTS FOR PEACE



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G-E LAMP TURNS SHELLS INSIDE OUT



TWO THINGS A GUNNER doesn't want to happen: (1) A dud shell. (2) a premature explosion. A big help in avoiding both is inspection of each shell to make sure it isn't pitted, greasy, or dirty inside. A slow job . . . until General Electric engineers helped work out this gadget that "turns shells inside out." As the girl spins the shell on rollers, a G-E reflector lamp, with a mirror arrangement that works something like a dentist's mirror, shows her every bit of the inside.*



THIS IS JUST ONE INSTANCE where G-E has had the lamps and the know-how acquired in peacetime, to solve war problems quickly. And speaking of inspections, this giant "electric eye" which tests light output is just one of 480 tests and inspections used to make *your* G-E lamps "stay brighter longer." *When you need bulbs, get the right size for the job . . . and make sure they're marked G-E!*

"TO MAKE LAMPS STAY BRIGHTER LONGER"
The Creed of G-E RESEARCH



*FREE! For 16-page booklet describing "Ordnance Inspection Methods With Light", write General Electric, Division 166-PSE, Nela Park, Cleveland 12, Ohio.

BUY AN EXTRA WAR BOND THIS WEEK!

G-E MAZDA LAMPS

GENERAL ELECTRIC

Hear the General Electric radio programs: "The G-E All-Girl Orchestra," Sunday 10 p. m. EWT, NBC; "The World Today" news every weekday, 6:45 p. m. EWT, CBS.

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Dependable ..CHAMPION SPARK PLUGS
ARE ON ACTIVE DUTY!

Maximum performance and dependability are the two qualities that are absolutely essential in spark plugs for our armed forces. Champion Spark Plugs have certain exclusive and patented features which insure these qualities and are being used by our armed forces, on land, water and in the air. The traditional dependability of Champions under the most adverse operating conditions is thus being emphasized as never before. You, too, can depend on Champions for better performance in every engine.

LET'S ALL BACK THE ATTACK—BUY WAR BONDS

Green Light for the Air Age

(Continued from page 122)

Recently, at one field alone, in one hour there landed over 75 planes. This is heavy traffic; when it is added that this was not local traffic about a metropolitan airport, but transoceanic traffic from America arriving at a field in Scotland, it becomes startlingly prophetic. If this is an indication of postwar transoceanic air traffic, what will be the congestion about continental ports that will handle not only air-line traffic but hundreds of private aircraft as well?

This is the problem that must be solved—and solved in time—to permit the anticipated growth of aviation. Its solution lies in the development not only of adequate landing and ground handling facilities for the aircraft—a problem in itself—but also of the means of visualizing and controlling the traffic pattern to get these aircraft into the ports.

Even the private pilot will have better radio equipment, linked through frequent monitor listening stations to weather stations from which he can obtain instant weather reports and other data vital to safe operation.

Long-distance air traffic which is not yet a part of any airport pattern will be held to its courses by a system of "fix" stations and beams, possibly automatically keeping the plane on course by their signals, entirely devoid of human assistance. These beams will be held true in direction and volume by monitor devices.

While most of the devices described above are purely speculative, they offer interesting possibilities and would, if developed, help solve the problem of postwar air traffic control vital to the realization of an Air Age.
—C. B. COLBY.



Model Builders Attention!

	V	V-2	V-3
Hex	1/2"	3/8"	5/16"
Thread	3/8"-24	1/4"-32	1/4"-32
Thread Length	7/32	7/32	5/32
Weight, Grams	8	3 1/2	2 1/2

Actual Size V-Plug

Champion spark plugs for model gas engines give the same dependable performance as regular Champions. Sillment sealed. Sillimanite insulator. Alloy needlepoint electrodes for easy starting. One-piece construction.

CHAMPION
SPARK PLUG COMPANY • TOLEDO, OHIO

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Other styles $5.50

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Made with unhurried care and styled for sound good looks, W. L. Douglas Shoes are, truly . . . Craftsmanship at Its Best!



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W. L. DOUGLAS SHOE CO., BROCKTON 15, MASS.

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BUY ANOTHER WAR BOND

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PRECISION PAYS OFF IN PERFORMANCE

More than 50,000 Allison liquid-cooled aircraft engines have gone to the United Nations fighting forces. ★ Into each of these engines have gone the precision and skill amassed by Allison and General Motors during the past quarter of a century. ★ Therein lies the secret of the power of Allison engines and their reliable performance in every major engagement of our Army Air Forces.



POWERED BY ALLISON:

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
A-36 and P-51—Mustang

LIQUID-COOLED AIRCRAFT ENGINES

Allison

DIVISION OF GM GENERAL MOTORS

Every Sunday Afternoon
GENERAL MOTORS SYMPHONY OF THE AIR—*NBC Network*

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Here's how your car FEELS...

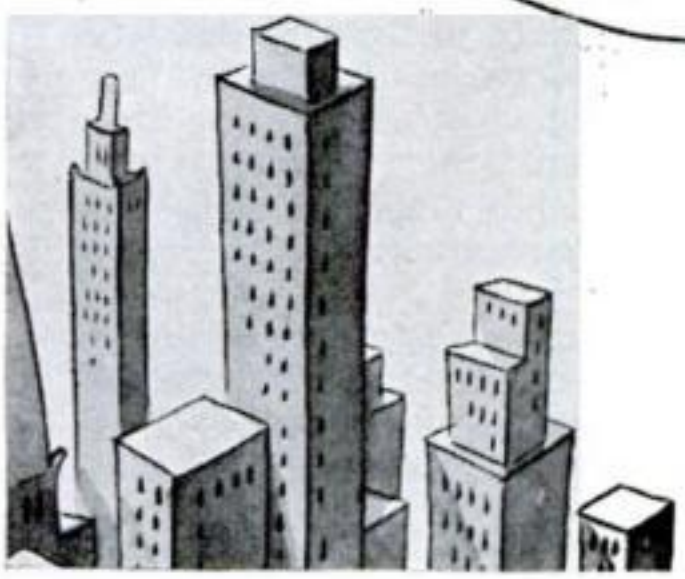


...after

MARFAK

chassis lubrication!

Car drive like a tank? Time for MARFAK chassis lubrication — Texaco's tough, long-wearing lubricant that silences, softens and soothes the crankiest chassis. MARFAK is applied by chart, never by chance. Every lubrication point is indicated — from control arms to rear shackles. Your car gets a careful check-up, too — every point of wear, every point of adjustment. Ask your Texaco Dealer to give your car that "MARFAK feeling" — tomorrow!





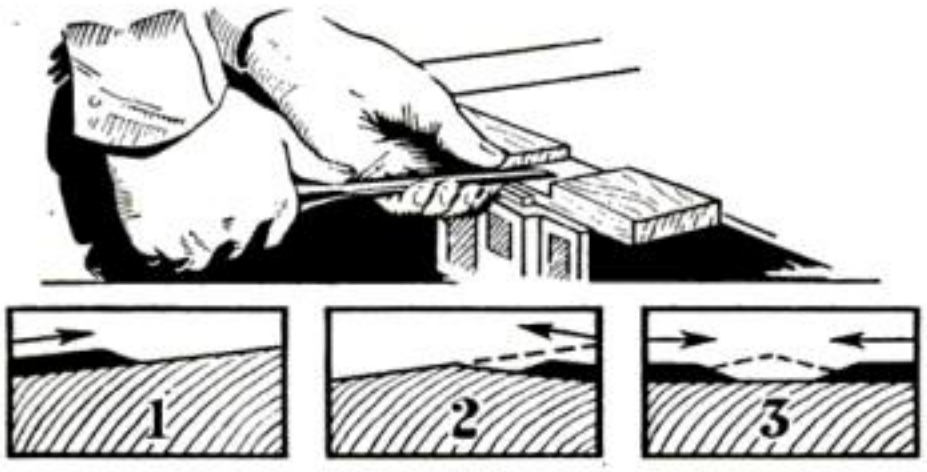


TUNE IN: FRED ALLEN every Sunday night. See your local newspaper for time and station.

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Tool Tips by STANLEY

HORIZONTAL CHISELING

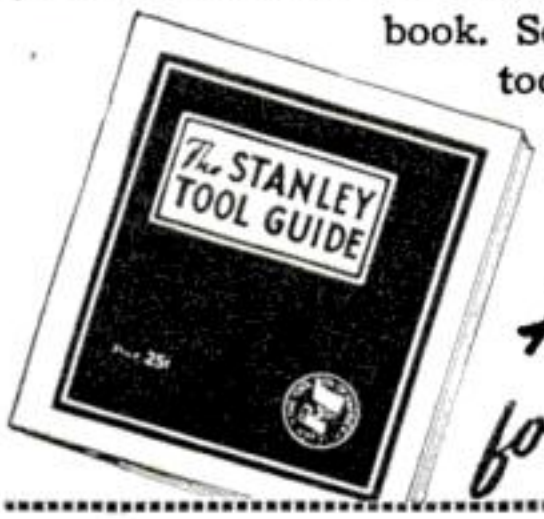


When cutting horizontally, *across the grain,* press the forefinger and thumb together on the chisel to act as a brake. To avoid splintering the corners, cut halfway from each edge toward the center. Remove the center stock last (see small sketches above).

To cut *with the grain,* the chisel is held slightly turned to one side to get a shearing action, and pushed away from the worker. For a roughing cut hold the bevel down, for a paring cut keep the bevel up.

Dozens of Proven Methods are Covered in the Stanley Tool Guide

More than 200 illustrations, with practical instructions covering the use of boring tools, doweling jig, spoke shaves, scrapers, planes, marking gauge, chisels, and other commonly-used hand tools are included in this one book. Send for your copy today, 25c postpaid.



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STANLEY TOOLS
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Enclosed find 25c. Please send me the Stanley Tool Guide, postpaid. (In Canada: Send coin or stamps to Stanley Tool Co. of Canada, Roxton Pond, Quebec.)

Name.....

Address.....

City.....*State*.....

Thunderbolt Ace

(Continued from page 56-H)

You have to aim ahead of him, allowing time for your stream of water to arrive at a certain point at the same instant he gets there.

As the boy runs to the left, you swing your nozzle ahead of him. Each drop of water goes out from the nozzle, in a trajectory curved downward by the force of gravity. But as the nozzle swings left, the stream of water describes another curve—toward the right—a curve in the stream though not in the course of the individual drops. Mahurin thinks of these two curves when he pushes the button on his guns.

Deflection shooting (with gun platform and target moving up to 400 m.p.h.) is a new art, of which the British are teaching our men much. The equipment is relatively recent. Why, only when Phil Cochran was learning to shoot, our American fighter boys used to file notches on their own primitive gun sights, to get them to their liking. Today's standard deflection sight is an optical instrument; the pilot looks into a glass screen on which a reticule is thrown in a pattern of light with a dot in the center.

The central dot is the aircraft's line of sight. The circle is gauged for a certain range. That is, an aircraft with 100-foot wing span will perhaps just fill the diameter of the circle at 300 yards. When the horizontal lines are adjusted, leaving one third of the diameter blank, that would just take the measure of an FW's span at 300. You set them for the aircraft you are gunning for.

But unless the pursuer is close and directly on the enemy's tail in straight flight, his target will seldom be within the circle. Rather, it will appear out along the horizontal, at 1, 1½, or 2 or more radii from the center, in accordance with various formulas the gunner has memorized, modified by his instantaneous judgment.

The British have found that in this judgment, range and speed are of much less importance than the gunner's estimate of the target's "angle off" the line of sight. Experience is the only basic guide in this, and to preserve experience from the split seconds of combat, a motion-picture camera is set in the leading edge of each fighter craft. This camera works while the guns are shooting and takes 64 frames a second. With a wide-angle lens, it gets the target even on a wide deflection shot.

Mahurin studied these combat pictures a lot, seeing—in slow motion which still seems

(Continued on page 216)



● You can't get by with today's gasoline if your motor is dirty, gummy, and full of sludge. Clean it out, and keep it clean, with CASITE.

BETTER and SMOOTHER PERFORMANCE or DOUBLE-YOUR-MONEY-BACK

It's as simple as that. Either your motor runs better and smoother with Casite, or you get back *twice* what you paid.

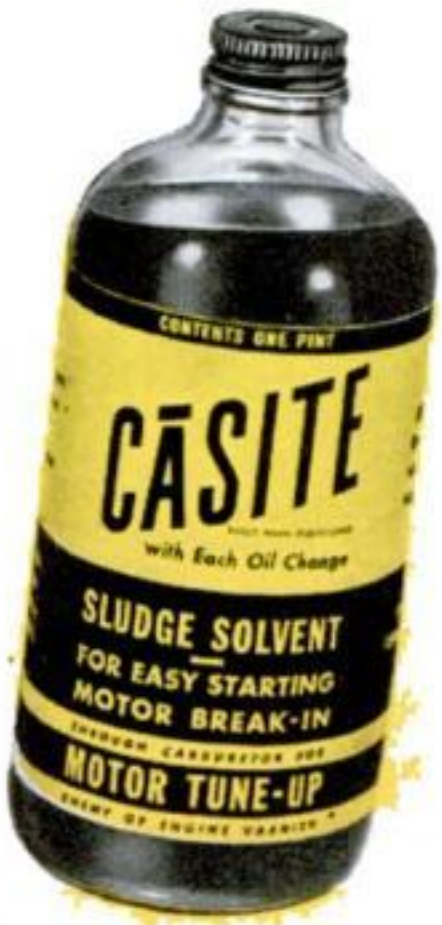
Millions bought and proved Casite last year under this broad guarantee —and solved the problem of dirty, sputtering, sluggish motors.

Profit from their experience. Start using Casite today. It costs only 65¢ a pint . . . is sold by garages, car dealers and service stations everywhere.

THE CASITE CORPORATION
HASTINGS, MICHIGAN

Guarantee

Add Casite to crankcase and run through carburetor according to instructions, then drive your car 100 miles or for 60 days, whichever is first. If not convinced that Casite gives you better and smoother performance, you get double your money back by filling out guarantee certificate and mailing it to The Casite Corporation, Hastings, Michigan. Maximum refund is $1.30 per pint, twice the nationally advertised price of Casite.



IT'S A PRIVILEGE TO BUY WAR BONDS

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TRAIL BLAZERS for TOMORROW'S SPORTSMEN

AMERICAN pioneers blazed the trails to straight shooting and the hardy outdoor life that makes strong men.

Like the pioneer, Stevens has blazed new trails in the production of sporting rifles and shotguns. In the years immediately preceding the war . . . Stevens introduced three *firsts* to give the shooter sporting arms better suited to his needs.

First to perfect a light, moderately priced automatic .22 rifle. It opened up the fascinating new sport of speed shooting at small running game.

First to introduce an over-and-under gun, combining .22 rifle and .410 shotgun barrels. It's a general purpose arm, equally suitable for vermin elimination or for hunting small game, winged or four-footed.

First to adapt Tenite for gun stocks. This durable, plastic material makes possible handsome, attractively checkered stocks, even in the most moderately priced arms.

★ ★ ★

When the war has been won and the Government authorizes civilian arms production, Stevens again will take to the *pioneer trail* and build accurate rifles and dependable shotguns, ideally suited to the shooter's requirements.

J. Stevens Arms Company
Division of Savage Arms Corporation
Chicopee Falls, Mass.

STEVENS

Two pre-war examples of Stevens' pioneering development.

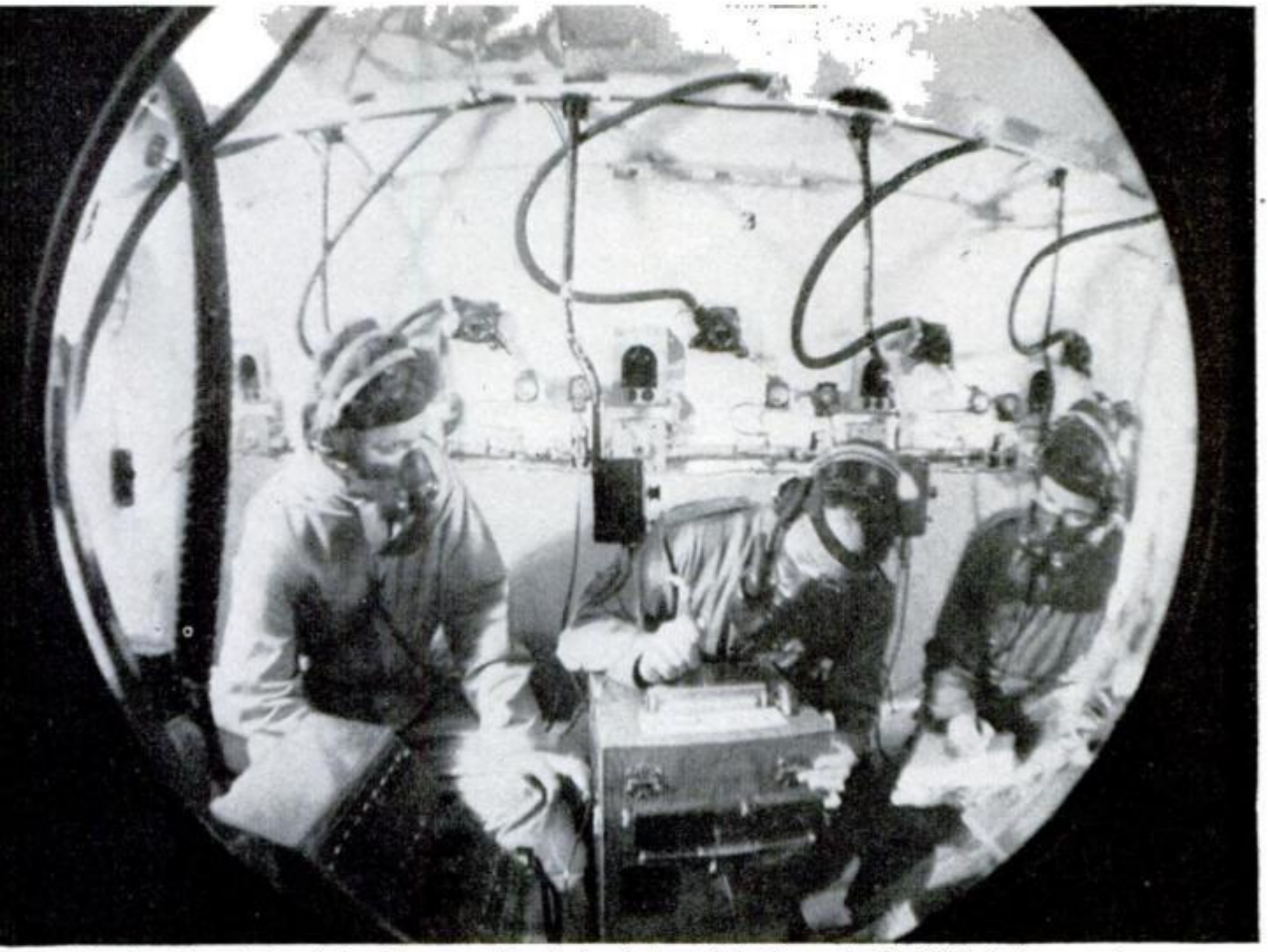


No. 22-410
Over-and-Under .22 Rifle and .410 Shotgun. An all-round gun for camper and vermin shooter.



No. 87 — *Three-in-one Automatic .22 Rifle. Fast growing in popularity before the War.*

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Massive Convair test chamber capable of simulating altitudes up to 80,000 feet, temperatures as low as 100° below zero for the study of materials and equipment under flight conditions.

Their Job: Destroying Liberators

THERE ARE people in San Diego who make jobs of destroying Liberators.

They spend hundreds of thousands of dollars on deliberate destruction to make the Liberator the safest plane in combat—for the crew...the deadliest for the enemy.

These people are members of the Consolidated Vultee Aircraft Corporation Engineering Test Laboratory, really a whole series of laboratories. As the Chief Test Engineer explains, "We ruin perfectly good equipment to find out what it will take. In that way we are able to work out many of the 'bugs' in an airplane long before it is flown."

In the laboratories, altitudes of 80,000 feet can be simulated; temperatures of 100° below zero can be produced. Every structural part and every item of equipment that goes into the mighty Liberator undergoes gruelling tests much more punishing than the actual test of combat.

For, in the Chief's words, "One test is worth a thousand expert opinions."

And the thousands of tests run on the Liberator frequently have direct bearing on the warming message, "All of our aircraft returned."

CONSOLIDATED VULTEE AIRCRAFT

LIBERATOR . . .	4-engine bomber	CATALINA	patrol bomber	VALIANT . . .	basic trainer
CORONADO . . .	patrol bomber	LIBERATOR EXPRESS .	transport	VENGEANCE . .	dive bomber
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Some things haven't changed!

LHS STERNCREST STERLING

Every pipe produced from genuine imported Mediterranean briar of pre-war quality, and shaped by the skilled hands of master craftsmen to be "A thing of beauty and a (smoking) joy forever". Sterling Silver band; solid rubber bit. Every pipe numbered, and registered by LHS, as your guarantee of pipe perfection.

$5

Smooth and Antique Finish.

Many handsome models.



"Perfection ... in a Pipe"

LHS STERNCREST 14K

The custom craftsmen of LHS select the very choicest grains for these patrician pipes. They finish them by an exclusive process that brings out the full beauty of the briar,—circle them with a band of solid gold. Truly, "Perfection—in a Pipe" $7.50

L & H STERN, Inc., Stern Bldg., Brooklyn, N.Y.

Makers of the famous
LHS Ultra-fine $10 Certified Purex $3.50 Superfine Purex $1.50

. . Put this in your pipe and smoke it:

BUY WAR BONDS

Thunderbolt Ace

(Continued from page 212)

very fast—what other pilots saw. He showed them to new pilots, elaborating on the fine points.

Even more important, from the precision standpoint, is the analysis given every combat film at Fighter Command, from which the fighter learns whether he is credited with a kill or how badly he missed his target.

Projected frame by frame, the film is stopped at a suitable point. In the projected light is placed a scale model of the target aircraft, mounted on a ball and socket. This model is manipulated until its shadow is precisely similar to the profile in the photograph. Since the line of sight is a known quantity, a scale on the model's base shows the "angle off." Calculations then indicate whether and where there was a hit. Most shooting misses, going to the rear of the target—not enough deflection.

For figuring angles, Mahurin had a lot of help during the latter part of 1943 from a new training device developed by Lt. Ernest D. Beatie, of Albany, Ga., a fighter pilot in the Eighth Air Force. Still something of a homemade contraption, this deflection trainer is set out behind the parachute racks. It is simply a standard sight mounted on a table, with stick and rudder controls. It is trained on a scale-model aircraft, mounted on ball and socket so that it may be set at any angle. When the trainee has taken aim, an assistant affixes a measured rod to the nose of the aircraft. A knob on the rod shows where the aim should be. Bud worked at this by the hour.

A fighter pilot in this war is a gladiator, a knight champion, a hot shot, an eager beaver, and a lot more. Especially, if he's really good, he's a precisionist—the serious practitioner of a highly complex, exacting game of skill.

Certainly, if he is not a good deflection shooter, he will never do the hat trick.

IV

The hat trick is an RAF term for the unusual feat of shooting down three enemy aircraft in one sortie. Mahurin was the first American in England to do it twice.

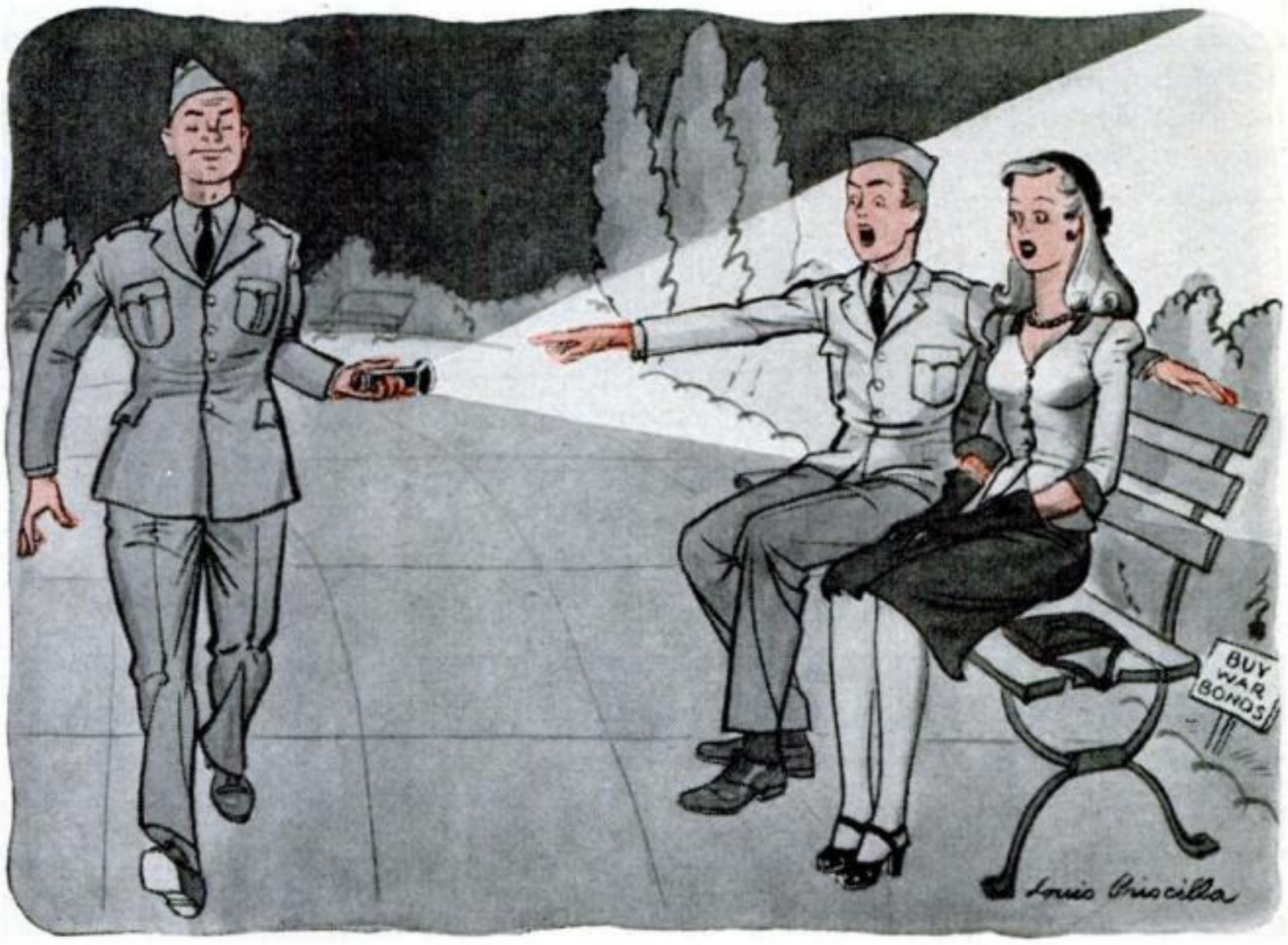
Mahurin doesn't think too highly of the times he got three in a day. They were "sitters," he says. All six were ME-110's, two-engined ships, not so maneuverable as a 109.

But these occasions were of sharp interest in the fighting over Europe. After the

(Continued on page 220)

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LIGHTER MOMENTS with
fresh Eveready Batteries



"You're violating the blackout, Sergeant."

A THOUGHT to keep in mind, next time your dealer is out of "Eveready" flashlight batteries: Nearly all we can make right now are being put to good use by either the armed forces or essential war industries.

You, personally, can save a soldier's life by giving a pint of blood to the Red Cross. They maintain Blood Donor Centers in 35 cities. Call for an appointment now!



FRESH BATTERIES LAST LONGER... Look for the date line →

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SCREWBALL IDEAS ON BATTERY CARE #2

Leave your motor running when parked for a recharge

The only trouble with this idea is that it won't work! It burns up "A" coupons fast; and further discharges the battery because an idling motor usually draws a net discharge of from 2 to 5 amps.



...THE WISE WAY IS PERIODIC RECHARGES!

Restricted driving is hard on batteries. Rationed mileage keeps them from getting the normal recharge from the generator, making certain precautions necessary if starting trouble is to be avoided.

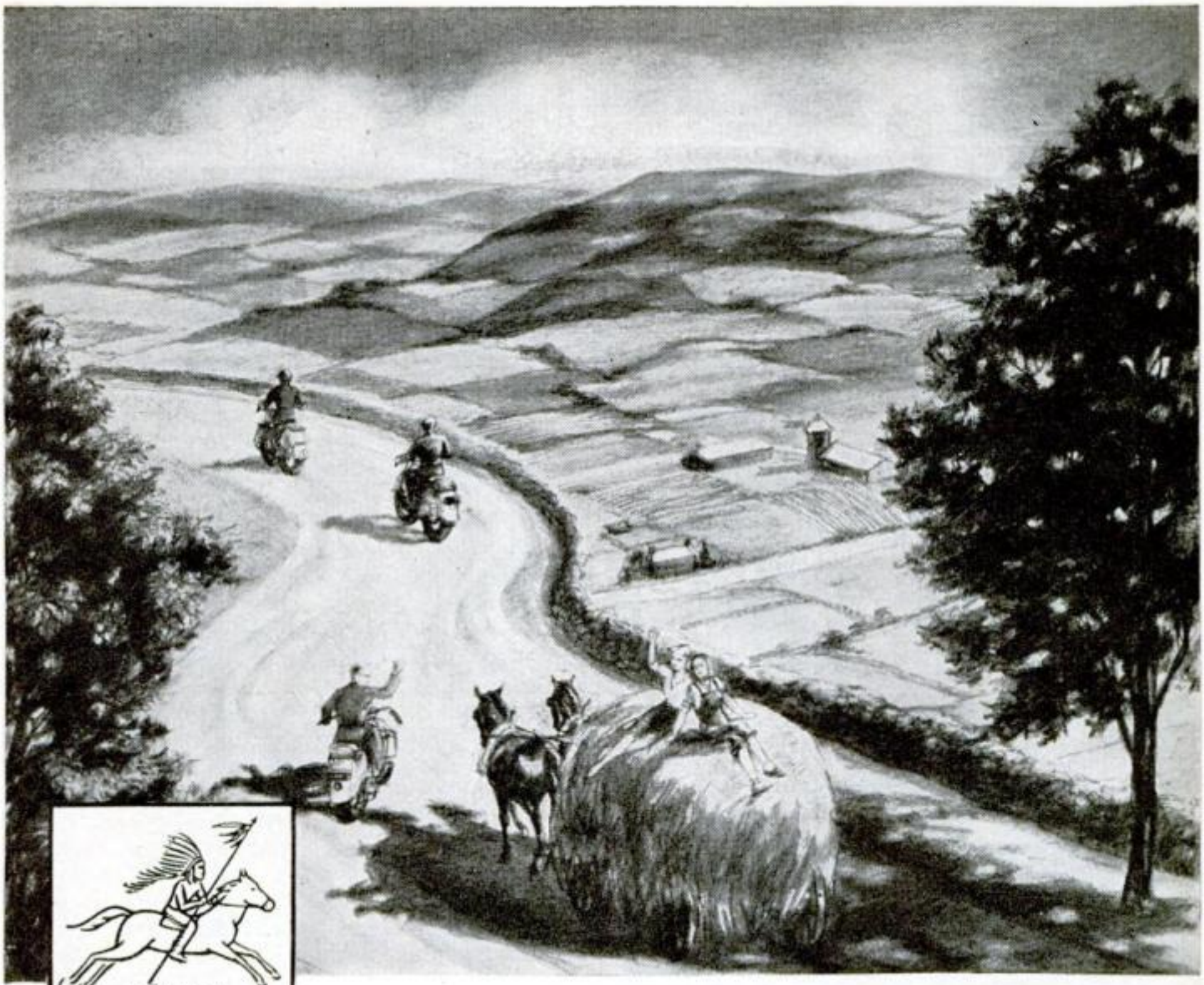
An experienced Exide Dealer knows how to keep batteries in top shape. See him for a check-up every two weeks. In many cases, periodic recharges may be just the right medicine for your battery, and with them, an Exide Dealer can put off the day when you'll need a new battery. When you *must* buy, get a dependable, long-lasting Exide. Buy to Last—Save to Win.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia 32
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EXIDES ARE USED IN MORE THAN 100 APPLICATIONS BY OUR ARMED FORCES

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INDIAN
TRAIL BLAZERS

Modern Indian Trails

Just off the highways of our nation, there are a million little tempting side roads that wind their way right into the heart of this great country of ours . . . modern "Indian Trails," teasing you to see what's at the other end. On an Indian you can "blaze" these trails easily, safely and comfortably.

One of the biggest thrills of "trail blazing" on an Indian is the feeling that you and your motorcycle are "one." Indians are alive with power. They give you a feeling of confidence and safety . . . respond easily to your slightest touch . . . and ride so smoothly you'll find it a pleasure to reel off the miles. Make your plans now so that when this war is over, you can enjoy motorcycling at its finest, in the saddle of an Indian.

INDIANS ON THE WARPATH

Right now, all new Indian Motorcycles go straight to war, and what a fighting record they're turning in! But new, improved, postwar Indians are already being blueprinted. *They're the motorcycles to wait for!*

Indian
MOTORCYCLES



BUY WAR BONDS NOW
TO BUY AN INDIAN LATER

Indian Motocycle Company
Springfield, Massachusetts

Read about Motocycling

Please send at once, a thrilling, action-packed FREE copy of *Indian News*.

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CLEAN SPARK PLUGS SAVE UP TO ONE GALLON OF GAS IN TEN

AC

SPARK PLUGS

BUY WAR BONDS — BRING VICTORY QUICKER

Thunderbolt Ace

(Continued from page 216)

Americans had introduced their belly tanks, the Germans changed tactics and started using rockets against the Forts. First they equipped single-engine ships with rockets, then all their fighters.

The Thunderbolts' next good hunting came in the October 4 raid on Frankfurt, when a swarm of 110's with rockets attacked the bombers. Bud's squadron fell upon them and got 13, of which he took three.

But it was on November 26, the raid on Bremen, that the really big kill came. Bud was on the first bounce and when he got down to bomber level, he found the sky filled with clumsy, rocket-bearing 110's.

"For cripe's sake, come down!" he cried on the RT.

Lt. Col. David C. Schilling, of Detroit, was commanding the group that day. He could see the 110's down below like a school of fish. He also had a clear view of the upper altitudes, which were free of enemy fighters. He made a bold decision. This was the time to break the rules. Schilling took the whole group down.

They had a Roman holiday. The three squadrons returned with a claim of 26 enemy planes destroyed. Fighter Command eventually credited them with 22 destroyed, four probables, nine damaged. That day Bud also broke the rules. Separated from his wing man, he didn't make for safety, but stuck his neck out, went around free-lancing on his own. He shot down his second three.

More memorable to Bud were such times as the two combats he had on November 3, the raid on Wilhelmshaven. This was another time that Whisky flew his wing.

On the way to meet the bombers, Mahurin saw some 109's coming in on the tails of four P-38's. He bounced, taking his whole flight with him. Lt. Wayne J. O'Connor led the second element.

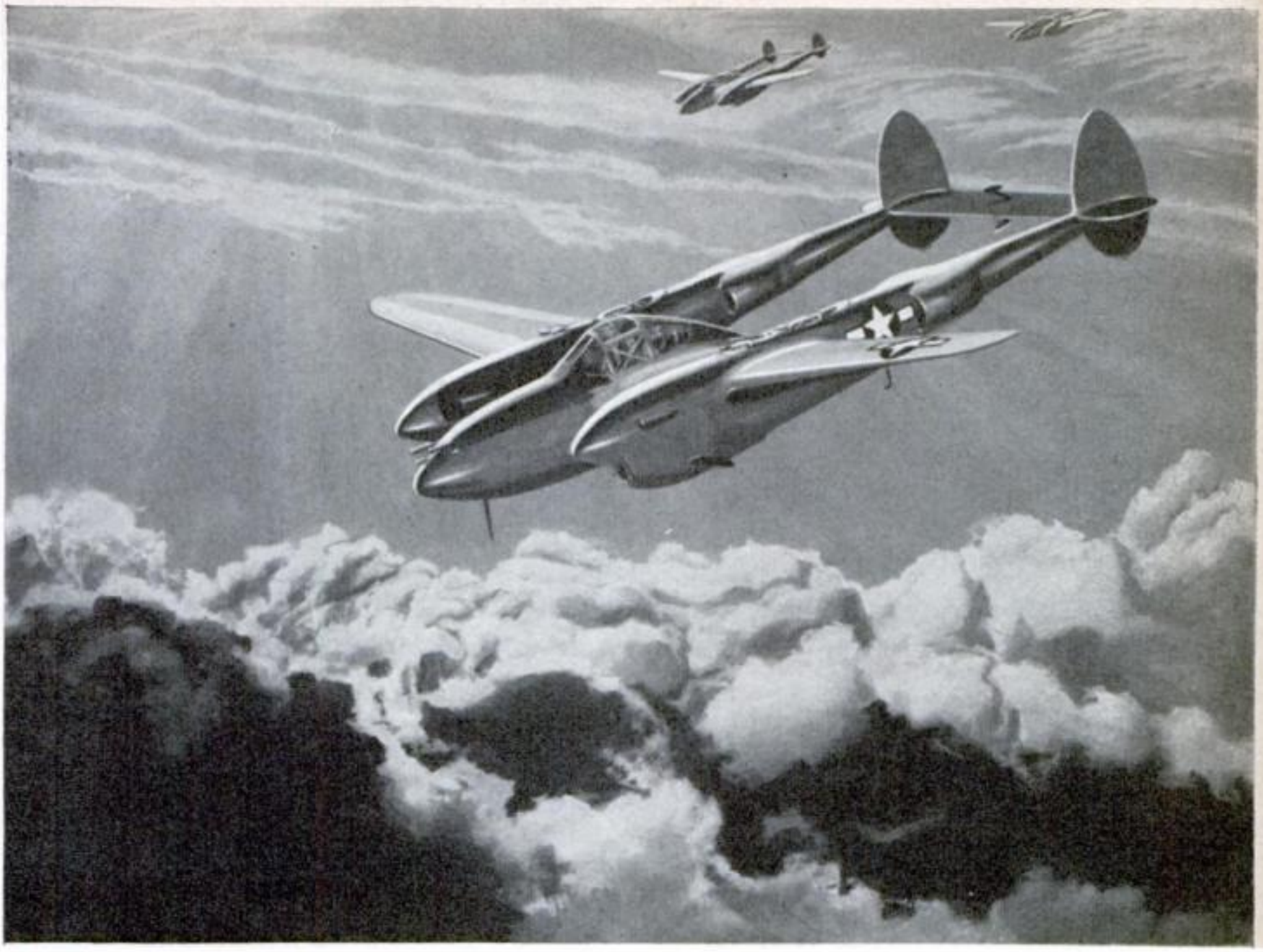
Mahurin hit a 109, closed in, then circled to make another pass. As he came back, Butch O'Connor was on the Jerry's tail and hitting him. But the 109 still staggered. Bud closed in a second time and made the kill.

When the results of this action were assessed by Fighter Command, the final decision was to credit the squadron with one plane destroyed and Mahurin and O'Connor each with one kill.

Bud and Whisky now found themselves flying alone. Suddenly they came upon a

(Continued on page 230)

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FINGER-TIP CONTROL FOR SPEED FASTER THAN SOUND

When an Army Air Forces officer power-dived the Lockheed *P-38* faster than the speed of sound (780 m.p.h.), he proved that the plane was appropriately named *"Lightning"*.

Now Lockheed engineers have given "finger-tip control" to its fantastic speed by installing aileron boosters actuated by the revolutionary Hycon "Stratopower" hydraulic pump. The application of these boosters, made practical for the first time, turns the *P-38* into a *dog-fighter which out-maneuvers many single-engined ships!* And the faster response of *all* control surfaces makes it a deadly fighter—even in the thin air eight miles up.

To help bring victory in 1944, we are increasing our output to the limit, and every Hycon "Stratopower" pump is reserved for our fighting planes.

At the war's end—for Tomorrow

Because of its compactness and phenomenally high pressure, furnishing *variable volume up to 3000 pounds per square inch*, the Hycon "Stratopower" pump will do a great many hydraulic jobs *better*

Today there are available other Hycon pumps and valves in the 3000 pound range for commercial applications to control or actuate machine tools, giant presses, dump truck lifts, materials-handling mechanisms and remote control circuits. They will operate brakes, clutches and steering devices of heavy vehicles; test high-pressure apparatus, and solve a wide variety of other hydraulic problems. Write for full information.



HYCON * * *

REGISTERED TRADE MARK

Stratopower Pump

LET'S ALL BACK THE ATTACK — BUY MORE WAR BONDS

Manufactured only by The New York Air Brake Company

THE NEW YORK AIR BRAKE COMPANY

Hydraulic Division

420 LEXINGTON AVENUE, NEW YORK 17, N. Y.

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Army Engineers "Give 'em the Works"



"What would the Ar-my do with-out the En-gi-neers?" pops the $64 question in "Song of the Engineers". A hard one to answer! Wherever the Army advances, in tropic jungle or Arctic outpost, the Engineers are out in front preparing the way . . . building air fields . . . throwing bridges across broad rivers . . . constructing highways over formidable mountains . . . resourcefully transforming "impossible" assignments into routine tasks.

Speed is a vital factor with the Engineers, and outboard motors have proved highly useful in ferrying and bridging operations. The Evinrude above, fresh from its packing case, will soon know what it is to "get the works" from the hard-working Engineers.



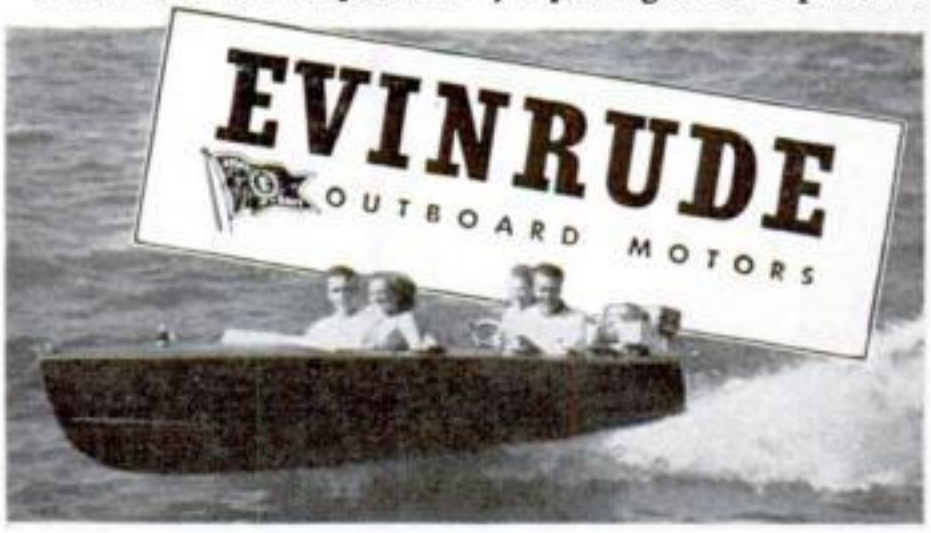
1 Mounted on the stern of a standard Engineers' ponton, (the Army term is *ponton,* not "pontoon"), this Evinrude makes fast work of transporting bridge material. It takes *stamina* as well as power to deliver the goods in this kind of service!



2 Ferries built quickly — here's how the Engineers do it! Several pontons are decked together with standard bridge material and, with motors mounted, the ferry is ready!. Here 3 Evinrudes do a "triple screw" job pushing a truck up stream.



3 Ready to go with another load. Such service is not as spectacular as that performed by the great Evinrudes that drive the Engineers' speedy Storm Boats, but it's as important — and it may have to be performed under battle conditions!



4 After Victory there will be thrilling new Evinrudes for all to enjoy! Today it is *our* job to deliver to our fighting forces the finest motors that all our skill and long experience can build! EVINRUDE MOTORS, Milwaukee, Wisconsin

EVERY DOLLAR YOU INVEST HELPS SPEED VICTORY . . . BUY MORE WAR BONDS

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There's Been a Big Change

WARFARE TODAY is more scientific—transportation more efficient, communication faster, materials more powerful.

There's been a definite improvement in tapered roller bearings, too. Transportation, agricultural, and industrial equipment all demanded a better bearing—a bearing with more rollers. Tyson developed that bearing—added *thirty percent more rollers* around the raceway.

Today, Tyson users get far greater load-capacity . . . more strength and rigidity . . . in many cases, *doubled* bearing life. The big name in bearings today is . . . **TYSON!**

TYSON BEARING CORPORATION, MASSILLON, OHIO

COUNT THE ROLLS · THE ROLLS COUNT



Tyson

TODAY'S HEAVY-DUTY BEARING

★ BUY MORE WAR BONDS ★

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Ingenious New
Technical Methods

Presented in the hope that they will prove interesting and useful to you.



Center Scope Brings Optical Precision to Machine Shop Operations

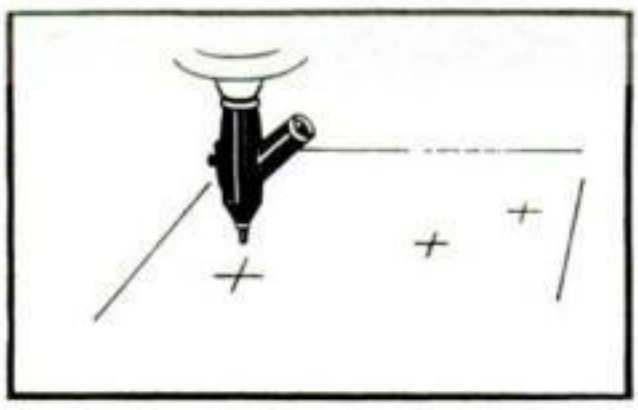
The Center Scope is an optical centering and locating tool that can be easily and quickly used on any machine to center work reference lines to a spindle axis. It permits accuracy to a degree never before obtainable, as the optical beam or line of sight is absolutely inflexible and cannot be distorted.

The Center Scope's easy accuracy eliminates many human errors, as the operator can see just what the cutting tool will do before it is actually fed into the work. It increases production, improves efficiency and prevents spoilage. There is no pressure on the work piece nor is it subject to wear or changes in temperature—for the Center Scope never touches the layout.

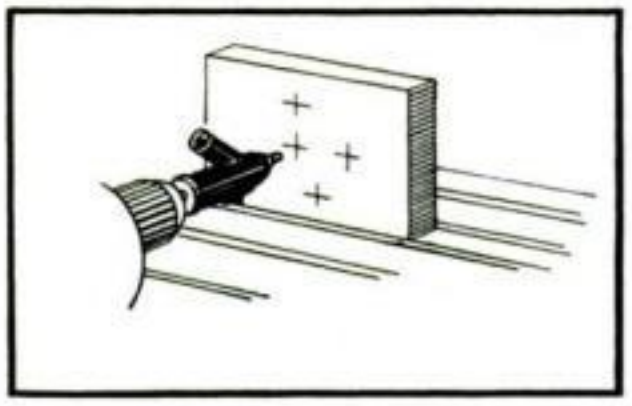
The Center Scope enables the operator to easily and quickly locate edges to a spindle axis, set-up faster and compensate for run-out. It saves vital hours in checking, inspecting and measuring when mechanical methods and tools are impossible to use. Its 45 x magnification allows operator to see ".001" and requires no technical knowledge or training to operate.

While there is nothing particularly new or ingenious about Wrigley's Spearmint gum, it is proving useful to millions of people in many new ways. Workers in war plants everywhere have found it helps keep them alert and relieves nervous tension and dry mouth while they are on the job.

You can get complete information from the Center Scope Instrument Company, 351 South LaBrea Avenue, Los Angeles, California, or Kearney & Trecker Products Corporation, Milwaukee, Wisconsin.



ON A VERTICAL MILL—locating and centering height gauge or size block layouts. Permits jig borer accuracy on more machines.



ON A HORIZONTAL MILL—the ability to center a layout, edge block or rotary table plug while spindle is running. Permits quick and easy set-up for high precision work.

Y-112

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a Magazine for Craftsmen



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- Plan for an attractive "Feeding Station" for birds.
- Directions for making a Ring Toss Game—fun for the whole family.
- Plan for a Wall Pipe Rack.
- Plan for Artist's Easel.
- How to make New Furniture from Old.
- Two designs with complete plans for modern Aquarium Tables.
- Plus pages of Shop Tips, News, etc., etc.



PLAN NOW to complete your shop with these and other outstanding Delta Power Tools after the war. Put every nickel you can spare into war bonds now so that you will have the money when these famous tools are again available for home shops.

What to make and how to make it

. . . 6 Big Issues a Year for only Fifty Cents!

"I sure enjoy the Deltagram and would not give it up for twice the price." . . . "Keep up the good work." . . . "The Deltagram is our shop bible." . . . Those are typical of comments we get from Deltagram readers all over the country. Young and old, novice and expert, they tell us how much help, how much fun, how many money-saving and money-making ideas they get from this bargain in homecraft material.

Practical

Published six times a year by the world's largest manufacturer of home power tools, The Deltagram is practical in every detail. Every project plan (and there are about 65 each year!) is tested right in Delta's own homecraft shop.

Every plan, every shop tip, every design is so crystal-clear and complete that even the beginner can follow it safely and easily, without costly waste of time and materials. In every issue you find items for the junior craftsman, as well as projects to challenge the expert.

"Knowledge is Power"

And knowledge is also fun, when it helps you get more enjoyment from your shop, helps you turn out better-looking, more praiseworthy work. Every page of every issue of The Deltagram adds to your knowledge — and for just 50 cents a year, 8⅓¢ an issue!

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Send your order now

Fill out the coupon below, tear it out and mail it today with 50 cents in check, money order, or stamps. Start enjoying your Deltagram right away.

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Editor, The Deltagram
THE DELTA MFG. CO.
683E E. Vienna Ave., Milwaukee 1, Wis.

Please enter my subscription for one full year (6 issues) of The Deltagram, for which I enclose 50 cents.

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Address.....

City.....(.....) State.....

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One More on the Nose!

A fighting flier wears his decorations on his chest. But a fighting plane wears *hers* on her nose.

And one look at the bombs and Swastikas painted on this B-26—"The Exterminator"—will tell you she's a two-fisted fightin' fool!

Like the notches on an old-time Injun-fighter's gun, they keep track of her score. A bomb for every one of her 40 successful missions . . . a Swastika for each of the six Nazi planes she's shot down.

"The Exterminator" fought her way through some of the war's hottest actions. She blasted Bizerte, Tunis, Sousse, Pantelleria, Sardinia, Naples and Rome. She "exterminated" the Germans' bridges, shattered their railroad yards, skip-bombed their ships. She pounded Salerno for a week to help pave the way for the 5th Army's landing.

Yet on all these flights, in all these fights, *not a man in her crew was scratched.* That's the kind of fighting record that makes bad reading in Berlin!

And that's the kind of team *you'll* be on when you fly with the A. A. F. . . . the hardest-hitting, best-trained team that ever took to the sky!

Bombardier, Navigator, Pilot, Gunner . . . whatever wings you wear . . . you'll hit the enemy often, and hit him hard. And you'll know how to get back home, so you can hit him again tomorrow.

And the Swastikas, or Rising Suns, painted on the nose of *your* plane, will be plenty of proof that you, too, are part of the "greatest team in the world!"

U. S. ARMY RECRUITING SERVICE



40 MISSIONS — NOBODY SCRATCHED

Every Bombardier, every Navigator, every Pilot, every Gunner who wears A. A. F. wings, gets training unequalled by that of any air force in the world . . . training that makes him a better flier and a better fighter than the enemy he meets.

MEN OF 17 . . .

You can get ready now for your place on the "greatest team in the world"—the A. A. F.—as Bombardier, Navigator, Pilot or Gunner. Go to the nearest Aviation Cadet Examining Board . . . see if you can qualify for the Air Corps Enlisted Reserve. If you qualify, you will receive the Enlisted Reserve insignia shown above . . . but will not be called for training until you are 18 or over.

When called, your special aptitudes will be studied further to determine the type of training you will receive. For the A. A. F. not only builds a combat crew from the pick of the crop, but carefully selects for each position the man with the best capabilities for the job . . . and then adds the thorough training which makes this all-star team the world's finest.

Prepare yourself in advance by taking C. A. P. Cadet Training as given by your local Civil Air Patrol. Also see your High School principal or adviser about recommended courses in the Air Service Division of the High School Victory Corps. Both afford valuable pre-aviation training.

(Essential workers in War Industry or Agriculture—do not apply.)

For information on Naval Aviation Cadet Training, apply at nearest Office of Naval Officer Procurement. This advertisement has the approval of the Joint Army Navy Personnel Board.

"KEEP 'EM FLYING!"

FLY AND FIGHT WITH THE AAF ARMY AIR FORCES GREATEST TEAM IN THE WORLD

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"Always Ready FOR ANY TEST"

HERE'S another typical letter from our far-flung battle fronts:

"In the past six months I've been riding Harley-Davidsons somewhere in North Africa. Have ridden other makes but none take the punishment that the Harley-Davidson has taken. I usually put about 200 miles a day on my motorcycle—so you can see I know what I'm talking about. She is ever faithful, always ready for any test."

That's the story of Harley-Davidson stamina and dependability in a nutshell. BUY WAR BONDS NOW—get set for your new Harley-Davidson as soon as the "fracas" is over—and the days come again for the fun and thrills of hillclimbs, endurance runs, race meets, gypsy tours and other exciting motorcycling events!



HARLEY-DAVIDSON MOTORCYCLES

FREE!

HARLEY-DAVIDSON MOTOR CO.
Dept. PSS, Milwaukee 1, Wisconsin

Write for free copy of ENTHUSIAST MAGAZINE filled with motorcycle pictures and stories.

ARMY E NAVY

SEND COUPON NOW

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Zenith's Crusade to Lower the Cost of Hearing

Brings High Quality within Reach of All!

The New Zenith Radionic Hearing Aid

Another Zenith "First"!

DAILY, all over America, hard of hearing persons who had given up hope of being helped, or who could not afford an adequate hearing aid, are finding a new world of happiness. They are discovering the thrill of "Radionic Hearing" with this high quality precision instrument at about one-quarter the price of other vacuum-tube instruments on the market today!

Zenith, pioneer in radionics and world's leading manufacturer of radionic products exclusively, has brought the hard of hearing "Another Zenith First." It places the fine precision quality that modern science and engineering can produce within reach of *all* who need it.

If we at Zenith never made a dollar on the New Zenith Radionic Hearing Aid, we would feel repaid a thousandfold by the expressions of delight, the smiles and in many cases the tears, of sheer gladness on the faces of these grateful people.

For the first time, many of them are able to hold vital wartime jobs and do their rightful share in Uncle Sam's wartime emergency. Many are hearing, *for the first time in years,* the voices of their children, their families, their friends. Handicapped youngsters, too, can now be saved from lives of failure and misunderstanding due to hearing deficiencies. 78% of all who are buying this revolutionary new instrument have never owned an adequate hearing aid before!

If you are hard of hearing, you owe it to yourself—your friends—and your country—to see a demonstration of the great advantages which ONLY ZENITH offers in a hearing aid. If you have a relative or friend who is hard of hearing, *you owe it to them* to urge attending a demonstration now going on at your local optical establishment franchised by Zenith. Let *their* ears be the judge. No one is pressed to buy. No salesman calls at the home. Meanwhile, send for our free descriptive booklet.

To Physicians: A detailed scientific description will be sent upon request. Further technical details will appear in medical journals.

*

There are cases in which deficient hearing is caused by a progressive disease and any hearing aid may do harm by giving a false sense of security. Therefore, we recommend that you consult your otologist or ear doctor to make sure that your hearing deficiency is the type that can be benefited by the use of a hearing aid.

Write for Free Descriptive Booklet, Address Dept. PS-4

ZENITH RADIO CORPORATION

P. O. BOX 6940A, CHICAGO 1, ILLINOIS

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$40

READY TO WEAR

Complete with Radionic Tubes, Crystal Microphone, Magnetic Earphone and Batteries. *One model*—no "decoys"...*One price*—$40...*One quality*—our best. Covered by a liberal guarantee.

Accepted by American Medical Association Council on Physical Therapy

ONLY ZENITH GIVES YOU:

1 The fine precision quality that modern knowledge and engineering make possible in a hearing aid, yet priced at only $40, complete, ready to wear. *One model*—no "decoys" . . . *One price*—$40 . . . *One Quality*—our best. You need not pay more or accept less.

2 Four-Position Tone Control. The flick of your finger instantly adjusts it to the most effective combination of low, medium and high tones for individual needs in varying surroundings, hearing deficiencies in various ranges. No further adjustments necessary.

3 Special Battery-Saver Circuit. Insures economy in battery consumption . . . results in substantial saving of battery life and battery replacement expense.

4 Zenith Quality—Zenith Guarantee. Zenith, world's leading manufacturer of radionic products exclusively, is fortunate in having the knowledge of precision production that makes possible this quality hearing aid at a remarkably low price. Guaranteed for a full year, with unique service insurance plan.

The Zenith Radionic Hearing Aid is available through reputable optical establishments franchised by Zenith.

BY THE MAKERS OF

ZENITH •LONG DISTANCE• RADIO

RADIONIC PRODUCTS EXCLUSIVELY—WORLD'S LEADING MANUFACTURER

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Actual photo of LEAKPROOF BATTERIES picked at random from 1939 manufacture.

THESE FLASHLIGHT BATTERIES ARE 4 YEARS OLD – *and* STILL FRESH

Remember when you picked up a flashlight, long unused, and found the batteries dead? The fact is, most flashlight batteries die just lying around . . . but not Ray-O-Vac LEAKPROOF Batteries. LEAKPROOF'S patented sealed-in-steel construction seals the power in . . . it's there when it's needed!

RAY-O-VAC LEAKPROOF BATTERIES ARE NOW GOING 100% TO OUR ARMED FORCES

RAY-O-VAC

FLASHLIGHTS · BATTERIES

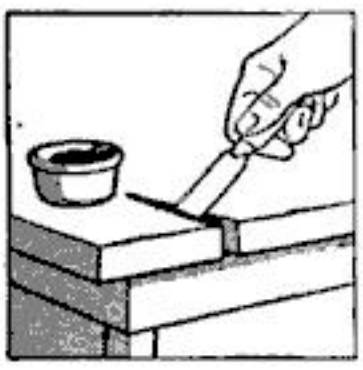
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OTHER FACTORIES AT CLINTON, MASSACHUSETTS • LANCASTER, OHIO • SIOUX CITY, IOWA

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WORKSHOP WISDOM

How to make a good crack-filler



HERE'S a low-cost filler for building up loose joints, filling gouges or cracks in furniture—and hundreds of other uses.

Mix 1 measure of Casco Glue Powder with 1 measure of water and let stand for 15 minutes. Then add it to a dry mixture of 1½ measures of sifted sawdust, ½ measure of flour, ½ measure of whiting. Mix to a heavy paste, using ¼ measure of denatured alcohol to smooth the filler.

Round the filler off slightly above the work to allow for slight shrinkage. Finish off with sandpaper when dry.

Casco Glue has a 4-point advantage

Unusual strength. Casco Glue hardens and sets chemically to form a bond of remarkable strength and toughness.

Greater durability. This glue is highly resistant to dampness, heat, and age.

Easy to mix. Casco Glue mixes readily with cold water . . . no heating problems.

Economical. A little Casco goes a long way. Mix it as you need it. The powder, if tightly covered, lasts indefinitely.

For special outdoor jobs and water projects, specify Cascamite—the completely waterproof plastic adhesive.

You can get both Casco Glue and Cascamite in 10c, 25c, and larger sizes at all hardware stores.

Write a post card today for free Casco Project Booklets and free Gluing Guide containing 80 household gluing hints. Address: Casein Company of America, Dept. S5, 350 Madison Ave., New York 17, N.Y.



CASCO Powdered Casein GLUE

"Sets chemically—hardens permanently"

Thunderbolt Ace

(Continued from page 220)

box of B-24's returning from the raid. Schedules were mixed a bit that day and their slight delay, from combat, had brought only their two Thunderbolts to the rendezvous which the rest of the group had missed. The two fell in to protect the big formation.

Soon they had a bounce. An ME-110 with rockets was coming in on the bombers. Bud hit him first, closing in with guns ablaze, then flashed past on the left. He was no more than 20 feet away and both the enemy pilot and rear gunner were looking him square in the eye, when Whisky's guns opened up, ripped the left wing, killed the gunner.

Bud made another pass. As he started from 400 yards and closed in, both the German's engines were smoking. Suddenly there was a maze of flashes, a belching of black smoke. Mahurin's Thunderbolt was splattered with oil.

One reason Mahurin is credited with kills and not with probables is that he closes in, hangs on until the end. It annoyed him on this occasion that it took two passes to finish each foe. He figured, however, that it was because he was working with three of his eight guns frozen.

V

Mahurin says his high score is mostly due to luck. He was one of the first to get a Thunderbolt, and started out as a flight leader—one who, like a football halfback, has a chance to score. He has been where the opportunities were. Would you believe it? Just before he got to the 2,000-hp. Thunderbolts, a mixup in orders once assigned Mahurin to an observation squadron for three weeks, flying a 65-hp. Cub!

Mahurin doesn't feel like a hero. He is just a fellow, at 25 a bit older than most of his mates, who is trying very hard to do a good job and who takes pride in his accomplishment. He is gallant and debonair enough, in his short-belted aviator's jacket, all shiny with wings, decorations, and six-guinea flying boots from Picadilly. But there's no swashbuckler here. He doesn't like to go to London much. It's so crowded, nothing much to do but go to shows; he doesn't know any girls down there.

But he doubtless will be judged a hero by the folks back home, for America loves its stars. It is already, up to the spring of 1944, fighting its war over Europe with an all-American varsity. And Bud happened to be the first high-scorer of that team.

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MEET YOUR NEW NEIGHBOR

Everyone knows that the world is growing smaller through the development of Science and Industry—the War is a grim reminder of this fact . . . but when the job of war is done and the Peace is won the world will become a *Neighborhood of Nations*—working and living together for their mutual betterment.

Radio will serve the world in a measure far greater than ever before—for pleasure, education, safety and convenience of *all* mankind!

Look to Hallicrafters—they are planning ahead TODAY for *your* radio TOMORROW—plans born of wartime manufacturing experience and engineering developments.

hallicrafters RADIO

THE ALL OUT EFFORT of the people of Hallicrafters has won for them the honor of being the 1st exclusive Radio manufacturer to win the Army-Navy Production Award for the 3rd time . . . FIFTY MILLION DOLLARS worth of war research and developments will be built into your next Hallicrafters Radio!

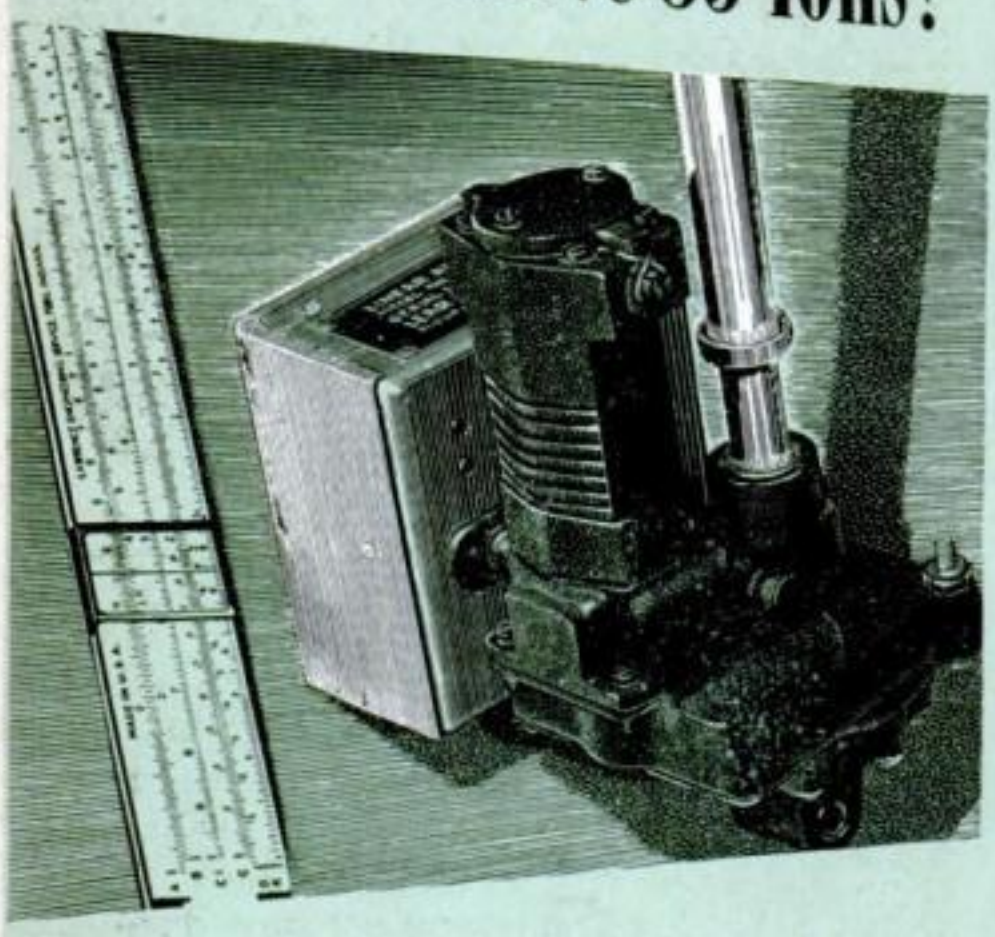
BUY MORE BONDS

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.

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Want to move 35 Tons?



WE wouldn't tell you how fast America's fighting planes go. That's a military secret.

But we've all read it's well over 300 miles an hour.

We've read too how they hit 700 or 800 miles an hour in dives. And how paint was peeled by the air pressure.

Did you ever stop to think that the plane's flaps and controls have to work surely, smoothly and dependably against pressures like that?

It's done by such mechanisms as you see in the picture.

They are called Lear Actuators.

They are powerful. Some can push up to 75,000 pounds.

They are light. That's a "must" in aircraft.

They are small. They have to fit in available space.

A good many preconceived notions had to go by the board to meet all these requirements. For example, the little electric motor that runs them is full of revolutionary engineering refinements.

Every man and every minute we have now can't make all the motors and actuators that we would like to deliver for Uncle Sam's aircraft.

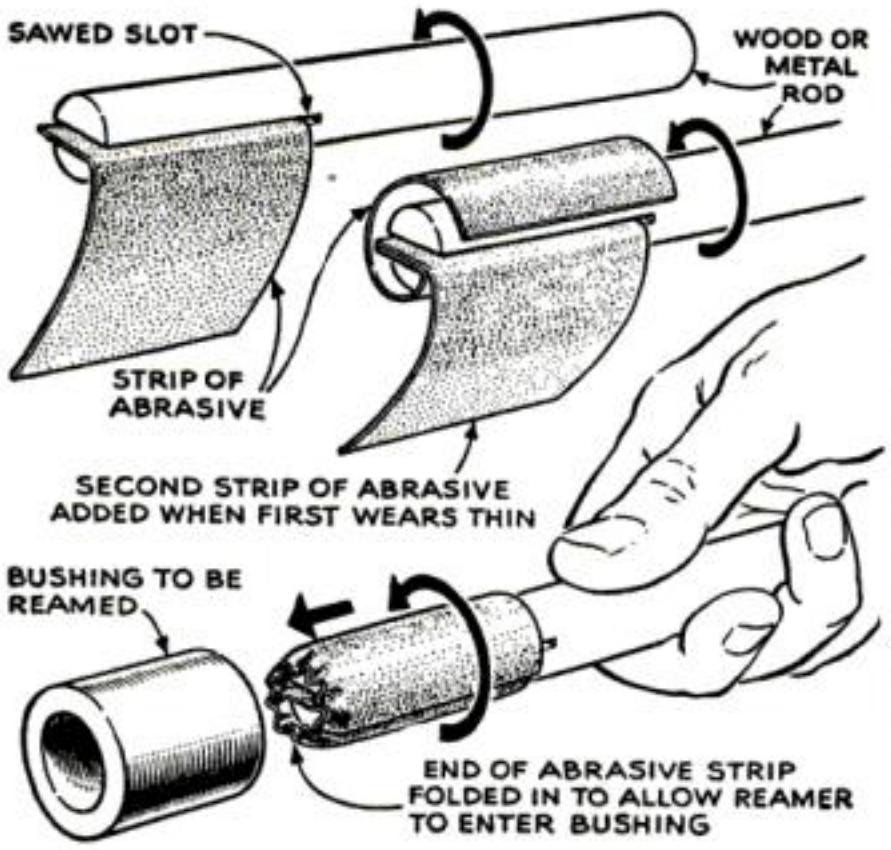
But the day is coming when they will have different jobs to do. New jobs on peacetime products—perhaps like steering ocean liners, or parking cars, or things we've never thought of.

That is one reason for this advertisement. We want to know who can use an actuator or a motor like these.

Another reason is, we want you to know that there is available the kind of thinking and engineering which have produced these and some 250 other Lear products.

LEAR AVIA INC.
PIQUA • OHIO

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Abrasive Paper or Cloth Acts as a Reamer for Bushings

A SLOTTED dowel or metal rod of the proper diameter, together with several pieces of abrasive paper or cloth, will serve as an excellent reamer in fitting small bushings. This method, illustrated above, is especially useful when a regular reamer is not at hand, though it is satisfactory for the careful and accurate fitting of small bearings to suit a shaft.

The length of the abrasive strips and the diameter of the dowel or rod should be such as to afford a tight fit when the improvised reamer is first twisted into the bushing and rotated. As the cutting grains wear off and as metal is removed from the bushing, it may be necessary for you to insert a second piece of the abrasive material in the slotted rod.—T. T.

Model-Plane Cement Repairs Leaky Camera Bellows

PINHOLE light leaks in the folds of a camera are often the cause of streaked or fogged negatives. If the holes are detected while they are still small, they can be readily repaired by painting the affected area with black model-airplane dope. If the holes or tears in the bellows are of larger size, it is possible to cover them with small patches of black cloth, cemented on by means of the dope.—ELMER F. ASHLEY.

Paper is a precious war material, packaging food, ammunition, weapons, and blood plasma. Save all you can to make sure these supplies reach our armed forces in perfect condition.



WILD TURKEY

"Here in West Virginia where we still hunt the native wild turkey, the terrain is rough and rugged, and our chances at game are often taken from one hill to another.

"My fondest recollections date back more than thirty years to the time I first came into possession of a Marlin rifle—a 32-20. Then followed a 25-20, a 30-30, and a Marlin lever action 22.

"All the Marlins I have owned were super accurate, efficient and trustworthy."

Thos. E. Knapp, Alderson,
West Virginia

★ ★ ★

Marlin thanks Mr. Knapp and the thousands of other sportsmen who have expressed appreciation for the accuracy and dependability of Marlin Guns. We are concentrating on war production until the war is won. After victory, however, Marlin will introduce new models and many improvements in its well-known line of rifles and shotguns.

THE Marlin
FIREARMS CO., NEW HAVEN, U.S.A.

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JOHNSON'S entire outboard production, of course, is for the armed services and essential needs. It's a two-way proposition. The armed services benefit from Johnson's twenty-two year experience in outboard manufacture. And Johnson benefits by "keeping its hand in" on the product for which it is famous.



When the war is won, we shall not merely pick up where we left off. We shall go on from where this new experience has taken us . . . Johnson Motors, Waukegan, Illinois.

DEALERSHIPS: Wherever you are located, if you are interested in sales AND SERVICE after the war, write us now.



There is No Substitute for Experience



DO YOUR DUTY—BUY WAR BONDS

JOHNSON SEA-HORSES FOR DEPENDABILITY



Scientific shear tests prove that Weldwood Glue "makes the glue line the Safety line." It is actually stronger than the wood it joins!

Wherever wood meets wood, this modern plastic resin adhesive does a quick and permanent "welding" job. It's one of the handiest "tools" a home hobbyist or repairman ever had.

Your hardware store or lumber dealer has packages of Weldwood Glue in 10c, 25c, 50c and 85c (1 lb.) sizes and 5 lb. cans. Get a can today or send 25c and your dealer's name for a trial 3½ oz. sample.

Weldwood Glue Has Everything:

1. Tremendous strength. **2.** Waterproof, bacteria- and rot-proof. **3.** Quick and easy to use. No heating. No waiting. Mixed just by adding water to powder. **4.** Economical. **5.** Applied cold, quick-setting. **6.** Stain-free. *Supply limited due to Uncle Sam's war needs.*





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"Makes the glue line the SAFETY line"

WELDWOOD
PLASTIC RESIN
WATERPROOF GLUE

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"Good Pictures"
BRING YOU TOGETHER

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This 56-page booklet is published by Argus to help solve the problems of exposures, lens, films, etc. Get your copy by sending 25c to Argus, Ann Arbor, Michigan. Dept. S.

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Avoid this winter's...

Chilly Chats



INCREASE HOME COMFORT WITH BALSAM-WOOL ATTIC INSULATION



Don't go through it again! If your home was chilly last winter—if you couldn't seem to get comfortable—do something about it right NOW. Balsam-Wool Sealed Insulation, laid in your attic, will step up *your comfort and step* down *your fuel bills—as much as 20%.*

It's so simple—so easy—to apply Balsam-Wool. This famous sealed blanket-type insulation is laid in your attic just like a rug. Once applied, it is there to stay—windproof, moistureproofed, fire resistant. Remember, too, that Balsam-Wool has proved its lasting value in hundreds of thousands of homes.

A money-back guarantee protects you when you buy Balsam-Wool—the most complete guarantee ever offered by an insulation firm. See your **lumber dealer** about easy monthly payments on Balsam-Wool Attic Insulation—or mail coupon for complete information.

Balsam-Wool

SEALED ATTIC INSULATION

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To assist us in giving you special information, please check: I am a home owner ☐ renter ☐ architect ☐ contractor ☐ student ☐

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LOW COST LENSES

Big 10 Page Project and Idea Booklet with all sets—describes successful developments—points the way to new experiments.

ALL LENSES NEW, finely ground and polished, edges very slightly chipped—**A SALVAGE BARGAIN!**

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Set No. 305-N "The Gadgeteer's Delight" 35 Lenses for $5.00 Postpaid. Contains all the lenses in the above set plus twenty more expensive lenses increasing your field of experiment and gadget making. All our lenses are neatly packed and marked.

Set No. 310-N "The Experimenter's Dream" 60 Lenses and New Complete 50 Page Booklet—$10.00 Postpaid. Contains all the lenses in the above sets plus 25 others that makes this a sensational buy. The variety of lenses in this set will enable you to conduct countless experiments and build a wide variety of optical equipment.

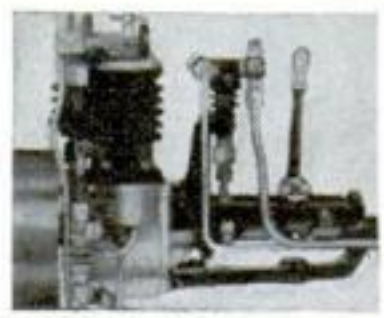
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27 W. Clinton Ave., Dept. 10, P. O. Audubon, N. J.



Build: STEAM ENGINE

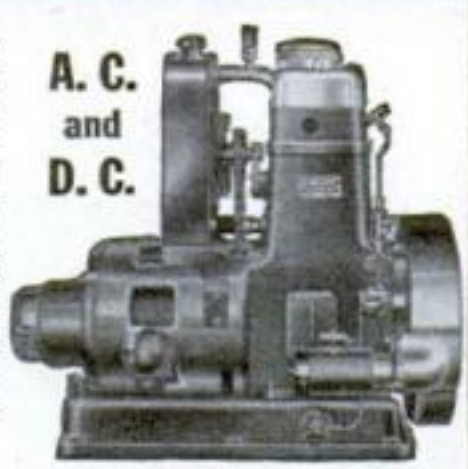
- A precision built and engineered single cylinder, ¼" scale marine model, with clutch or reverse.
- Send **$2.50** for 14 pages scale drawings, 2 photos, instructions.
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THOMPSON ENGINEERING CO. 214 NO. DIVISION BLDG., GRAND RAPIDS 2, MICH.

LOOK for New Post-War WITTE DIESELECTRIC PLANTS

The finest Dieselectric Plants ever to carry the WITTE name will be ready for you after victory . . . to supply power and light at amazingly low cost. Over 74 years manufacturing experience contributes to their reliability. Today, WITTE Units are serving the victory cause all over the world.

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LARGEST BUILDER OF SMALL DIESELS

KANSAS CITY, MO., U. S. A.

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PRELUDE TO A PERFECT FINISH



Finish must now be measured in micro inches. That's where the new **Chicago FV BOND** Wheels excel. They give a precision smoothness so intensified that it passes any surface analyzer test.

ARMY E NAVY

FV BOND is available in all types of **Chicago** Mounted and Small Grinding Wheels—in all abrasives, grain and grade combinations. It is the result of research and experiment on hundreds of aircraft jobs. **Chicago Mounted Wheels** are tough, long lived, dependable. Over 300 sizes, styles and grains.

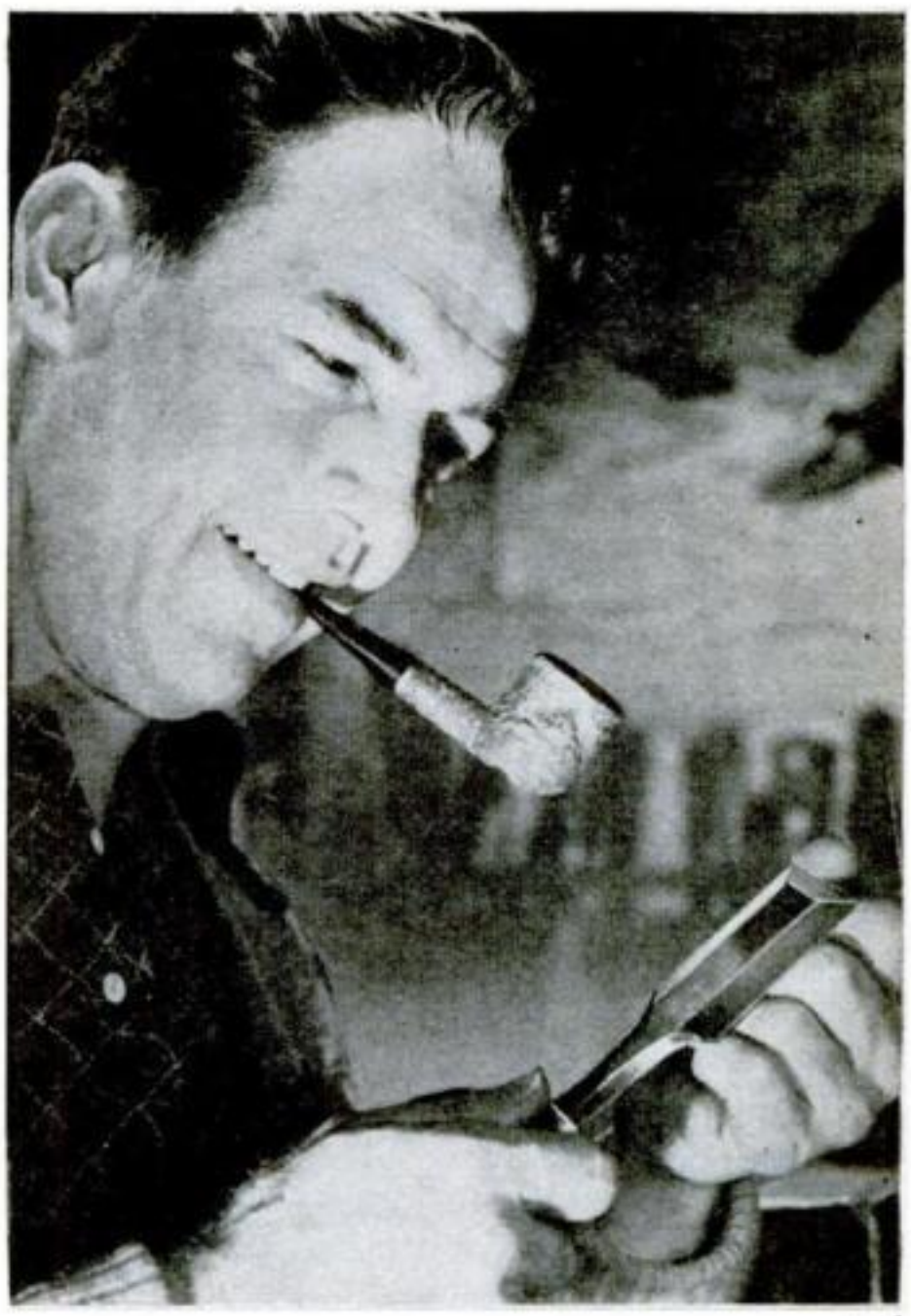
Chicago Grinding Wheels—Only sizes up to 3" diameter for the duration, with WPB approval.

AMERICA'S HEADQUARTERS FOR MOUNTED WHEELS SMALL GRINDING WHEELS

Handee Tool of 1001 Uses and **Hi-Power Grinders** are still available to all who have priorities.

Send for Free Catalog.

CHICAGO WHEEL & MFG. CO.
1101 West Monroe Street, Dept. PO, Chicago 7, Illinois



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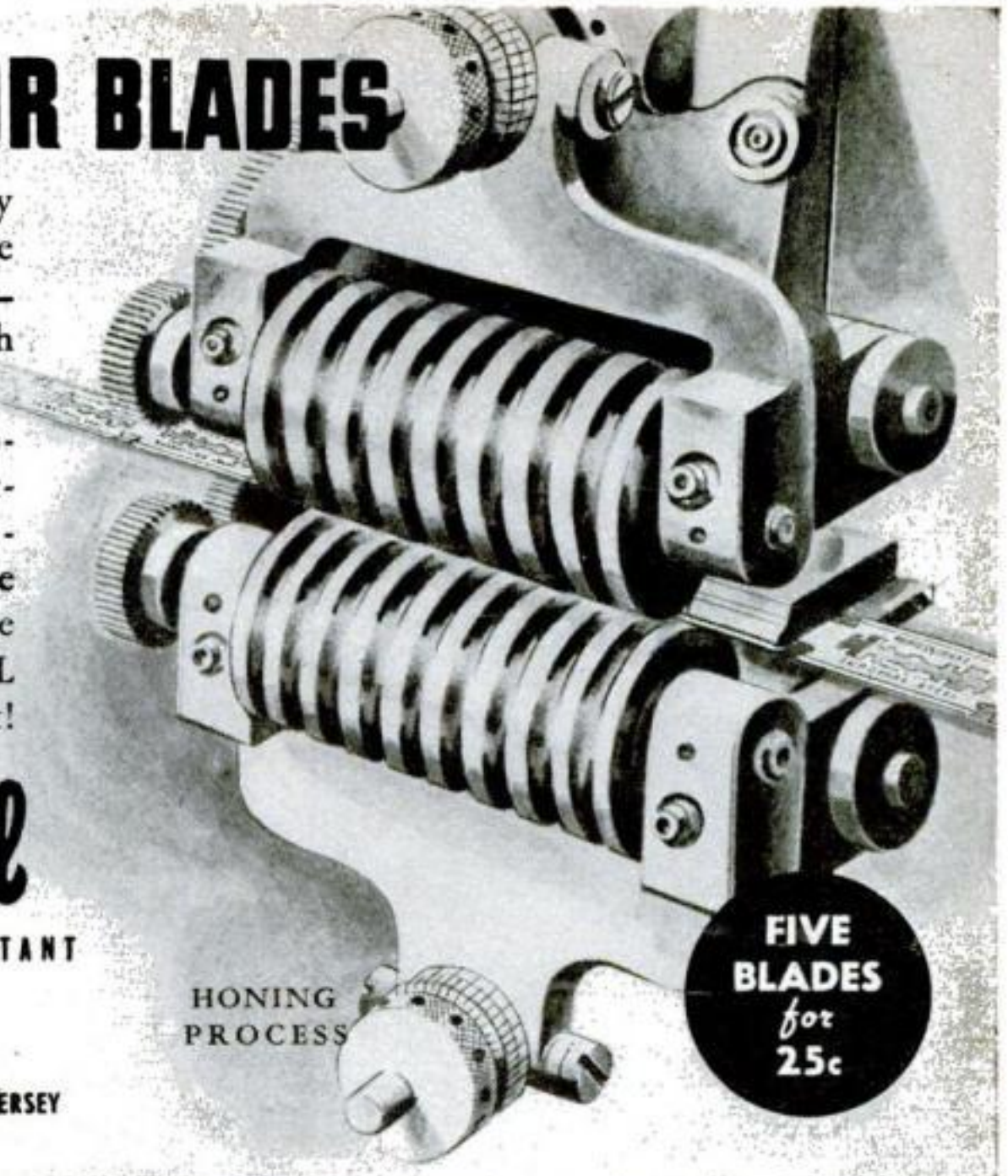
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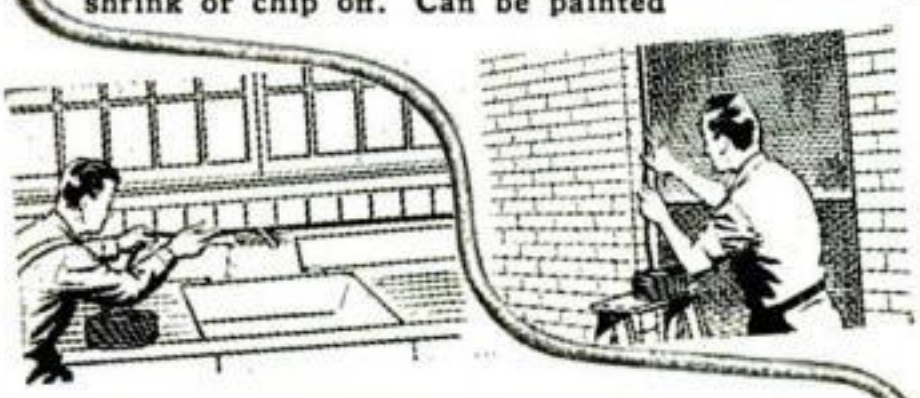
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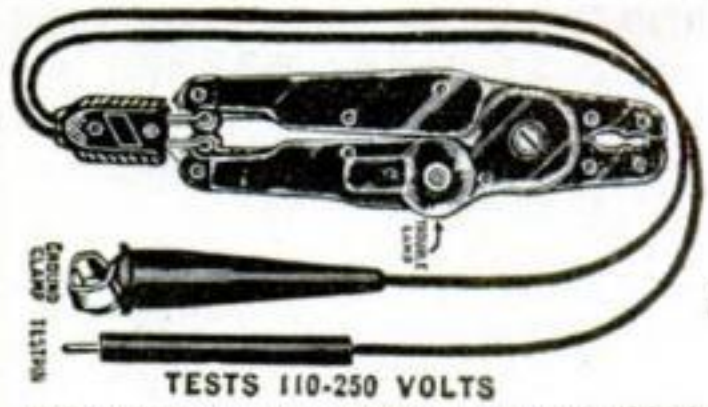
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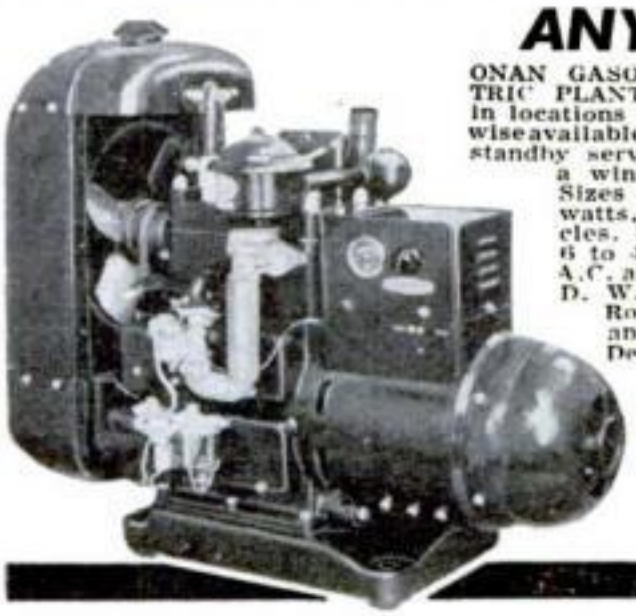
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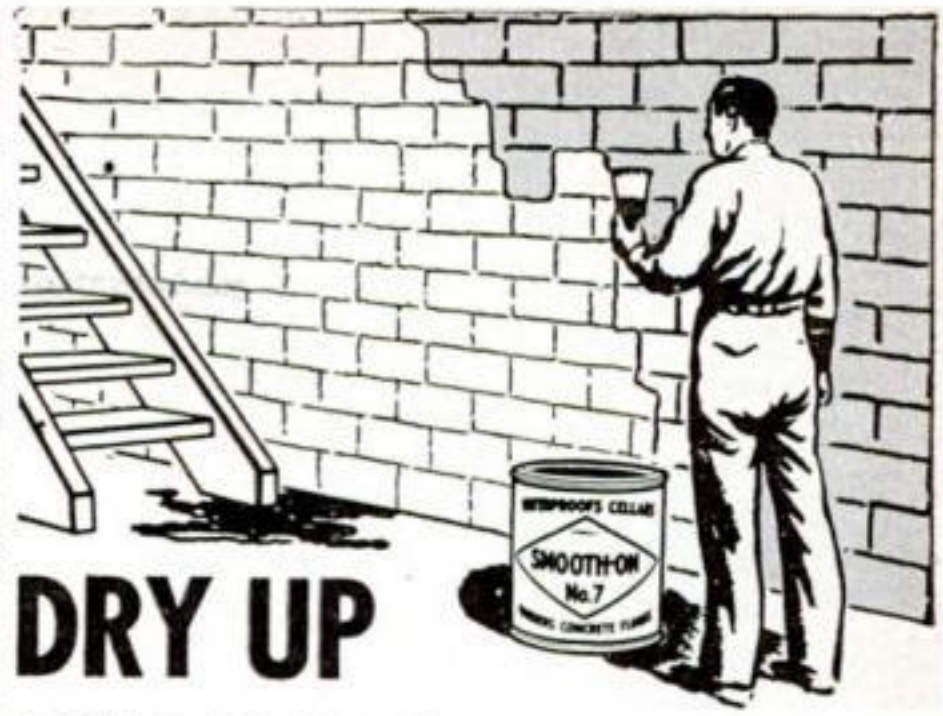
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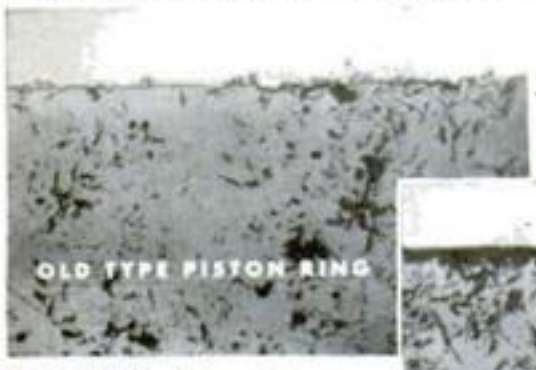
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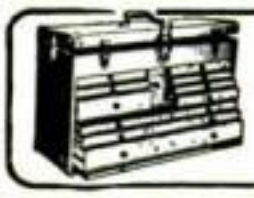
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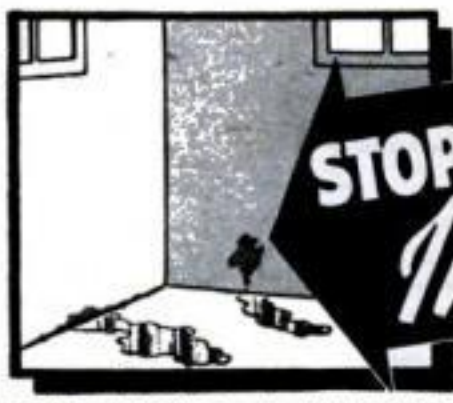
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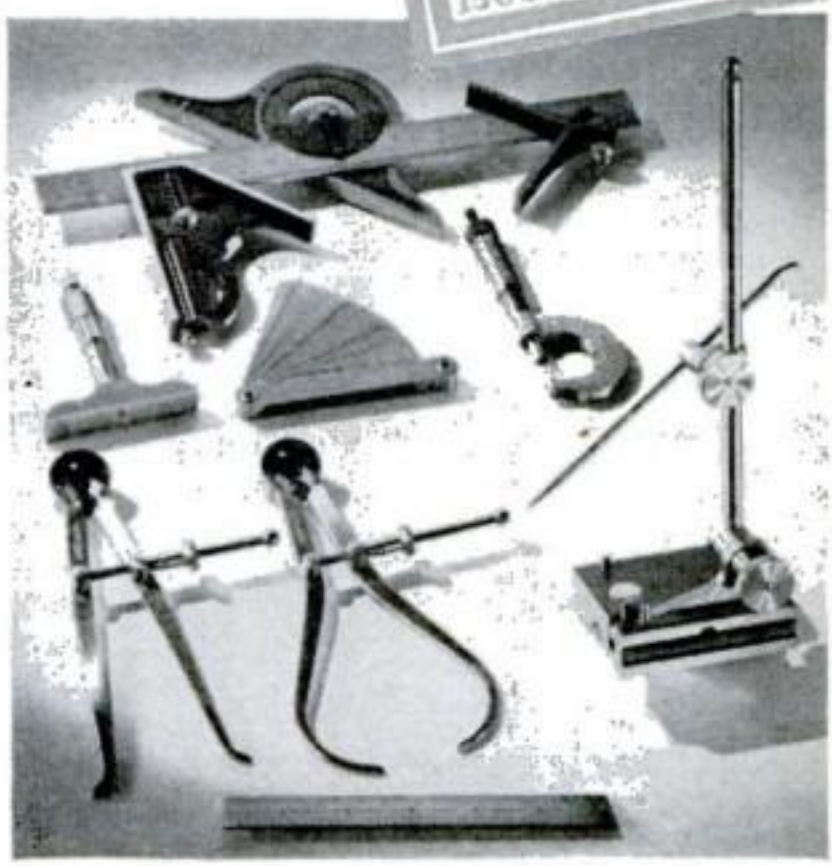
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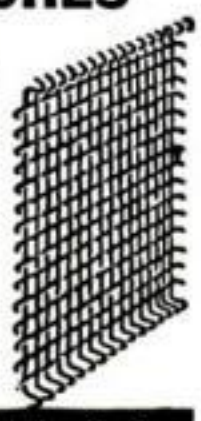
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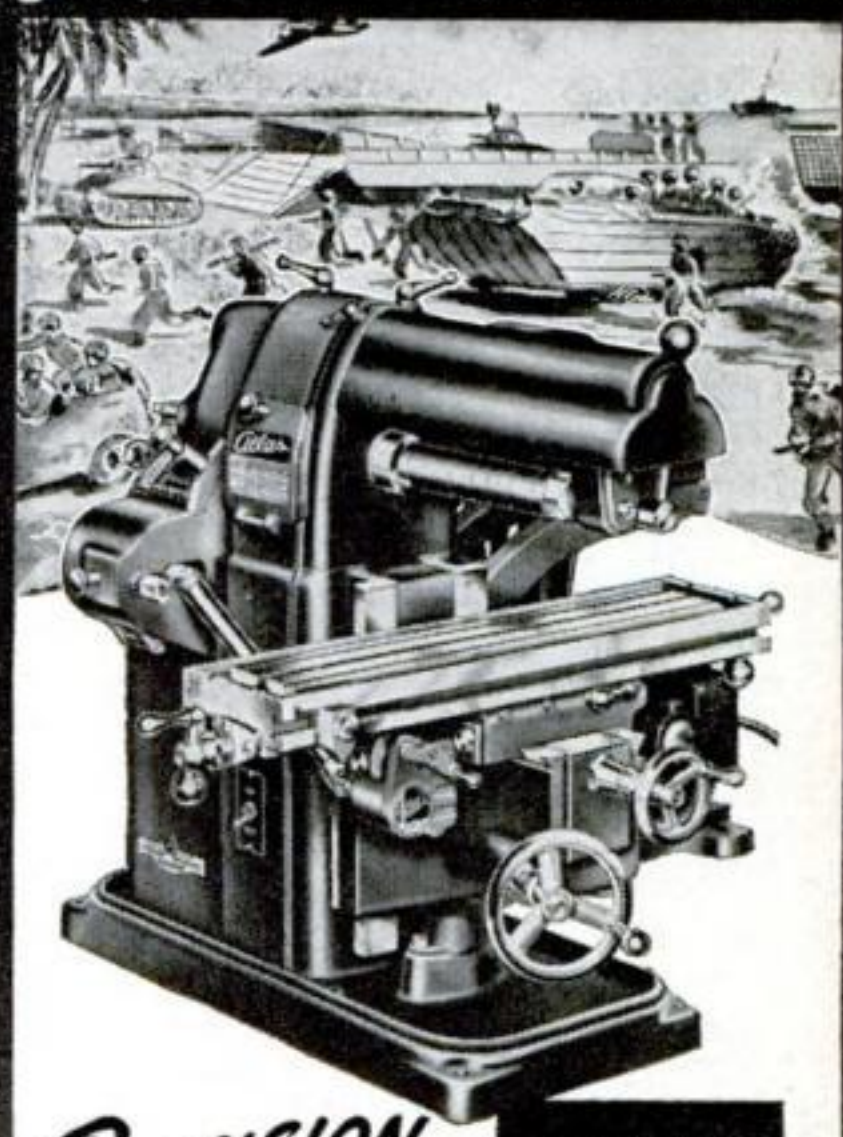
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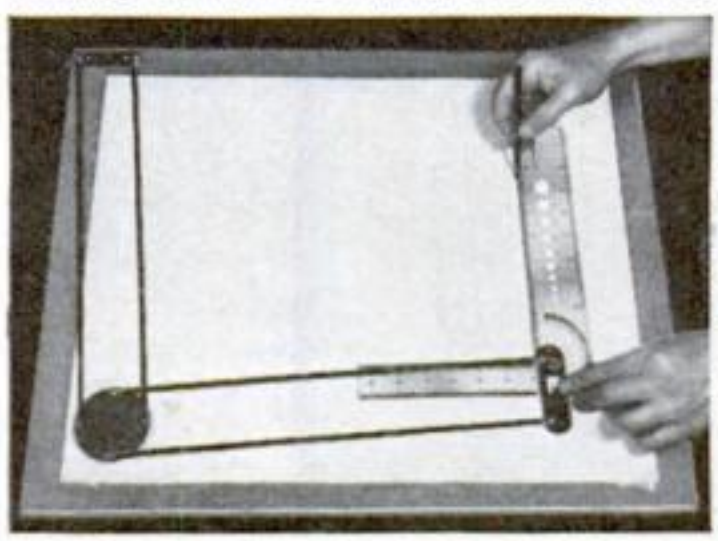
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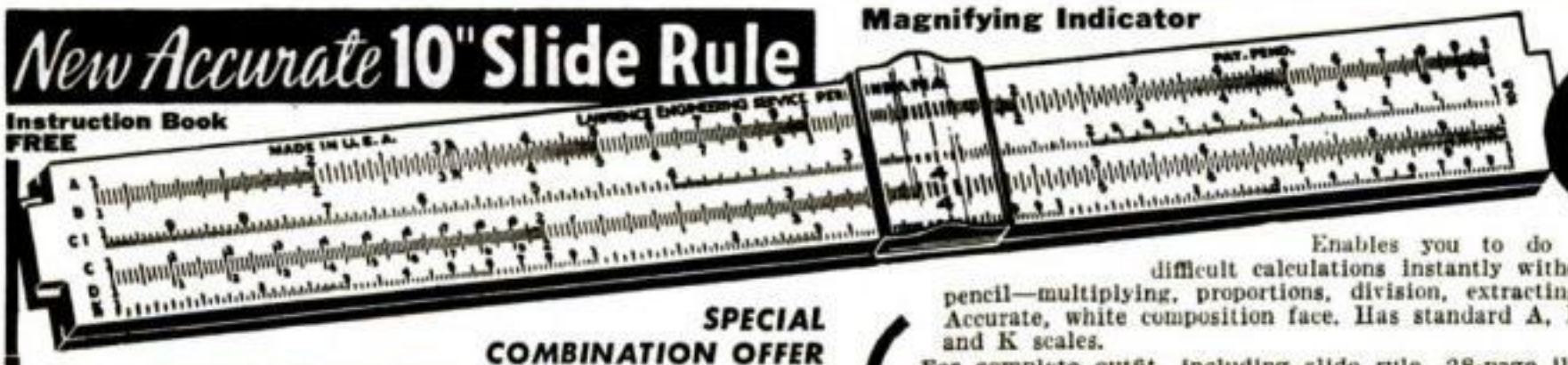


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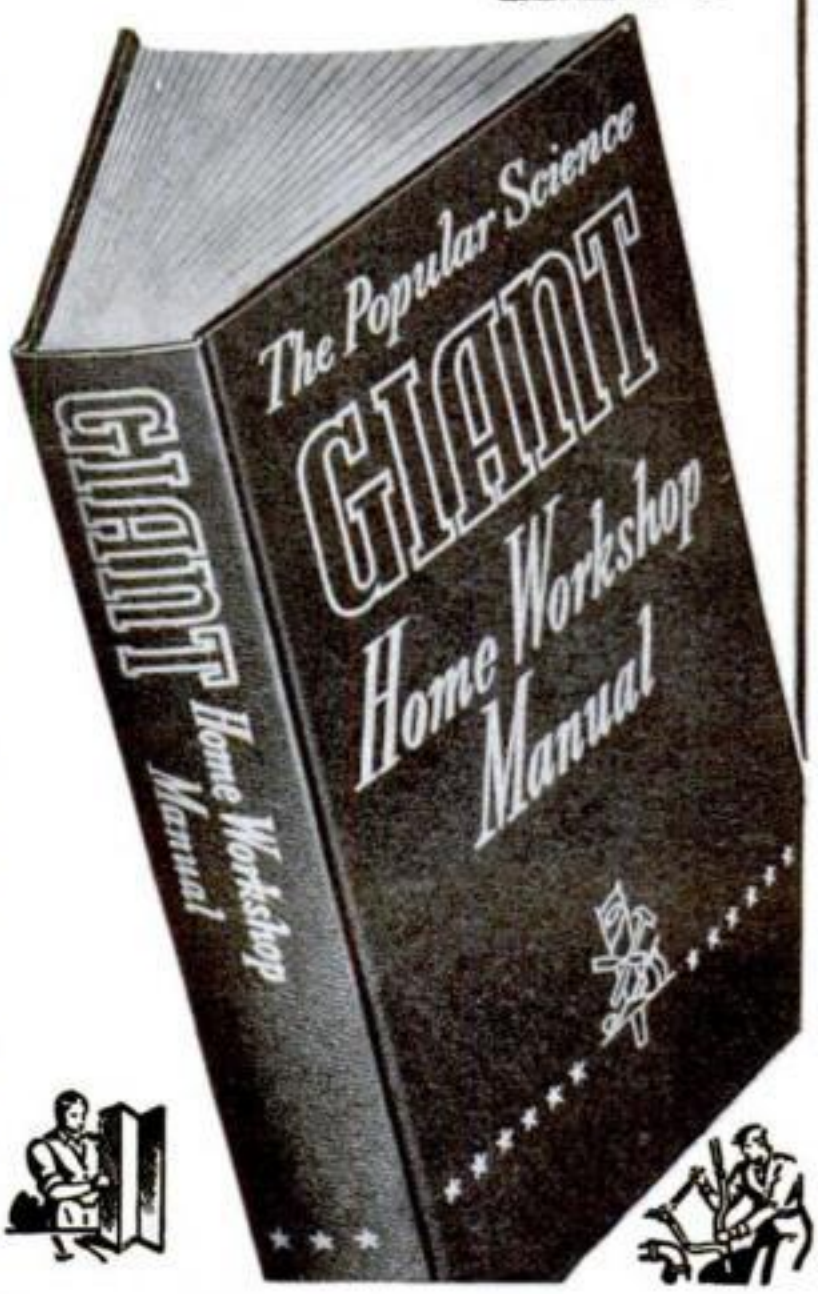
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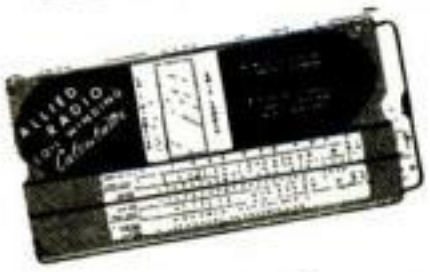
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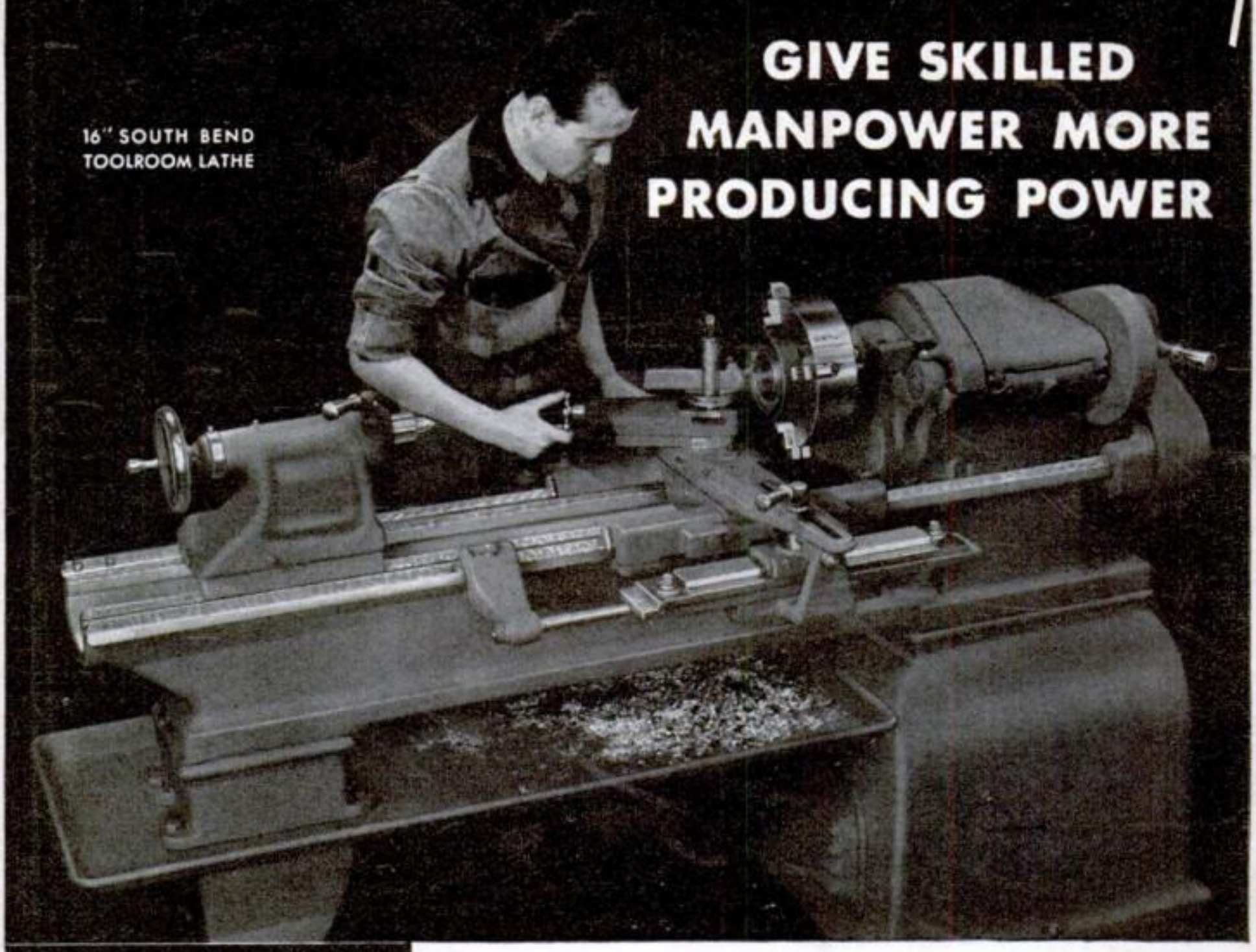
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